Национальный исследовательский университет "МЭИ"

Кафедра РЗиА

Лабораторная работа № 3

«РЕШАЮЩЕЕ ДЕРЕВО. КОМПОЗИЦИИ РЕШАЮЩИХ ДЕРЕВЬЕВ. МНОГОСЛОЙНЫЙ ПЕРЦЕПТРОН»

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In [3]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.ensemble import RandomForestClassifier
from catboost import CatBoostClassifier
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from category_encoders import TargetEncoder
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import confusion_matrix
from catboost import CatBoostClassifier
from sklearn.preprocessing import StandardScaler
from tensorflow.python.keras.utils import np_utils
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Activation, Dropout
```

In [2]:

```
data = pd.read_csv('income.csv')
data.head()
# y.head()
```

Out[2]:

	age	workclass	fnlwgt	education	education_num	marital_status	occupatio
0	39	State-gov	77516	Bachelors	13	Never-married	Adm-clerica
1	50	Self-emp-not-inc	83311	Bachelors	13	Married-civ-spouse	Exec managerial
2	38	Private	215646	HS-grad	9	Divorced	Handlers cleaner
3	53	Private	234721	11th	7	Married-civ-spouse	Handlers cleaner
4	28	Private	338409	Bachelors	13	Married-civ-spouse	Prof specialt

In [3]:

```
print("Пропущенные элементы")
data.isnull().sum()
```

```
Пропущенные элементы
```

Out[3]:

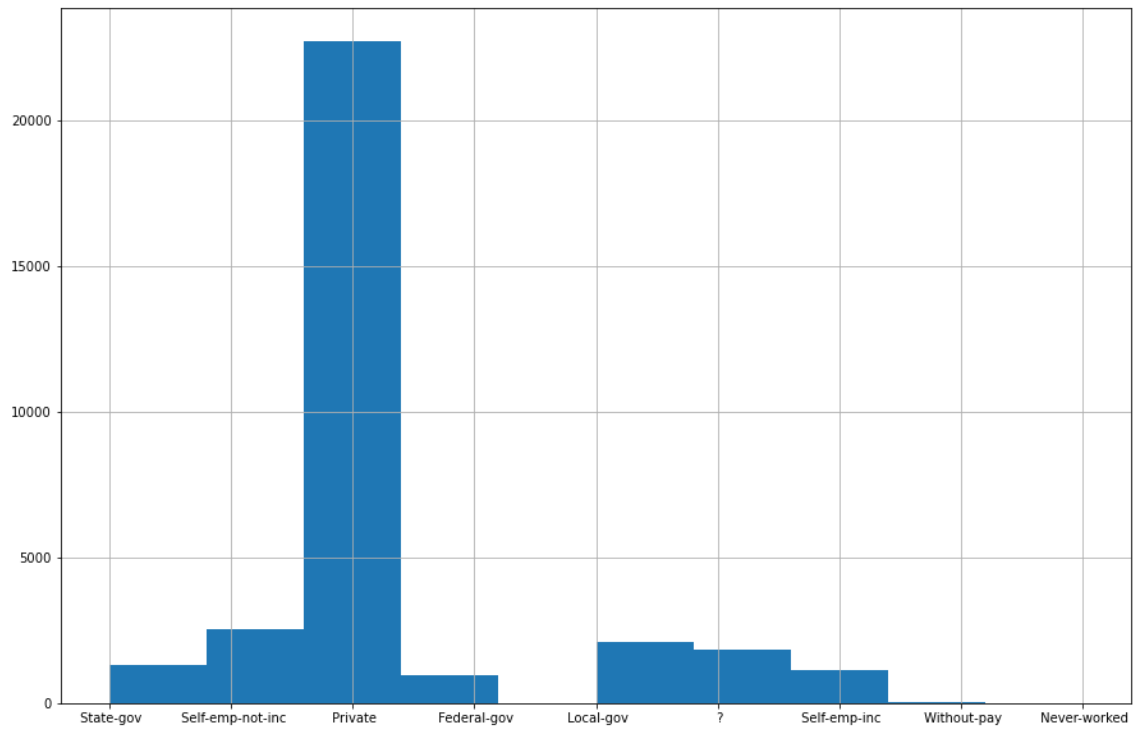
```
age               0
workclass         0
fnlwgt            0
education         0
education_num     0
marital_status    0
occupation        0
relationship      0
race              0
sex               0
capital_gain      0
capital_loss      0
hours_per_week    0
native_country    0
income            0
dtype: int64
```

In [4]:

```
data['workclass'].hist(figsize=(15,10))
```

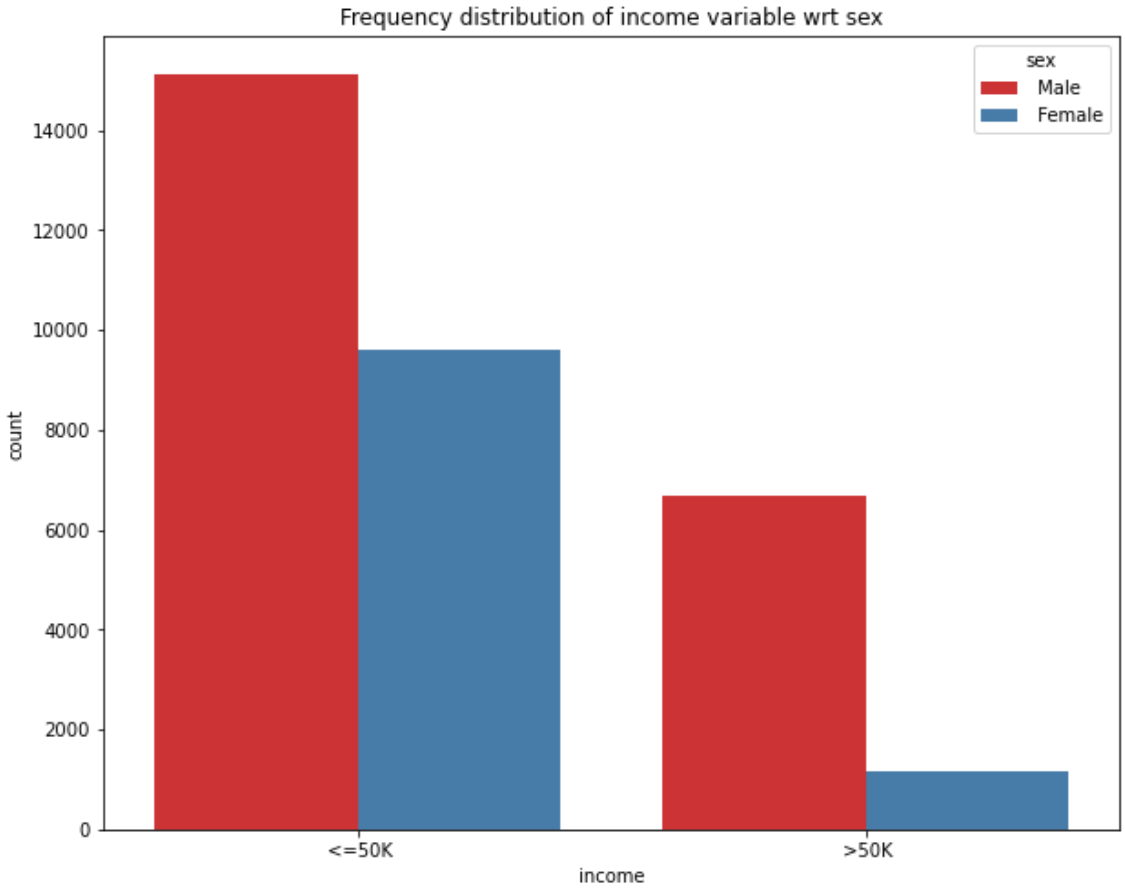
Out[4]:

```
<AxesSubplot:>
```



In [5]:

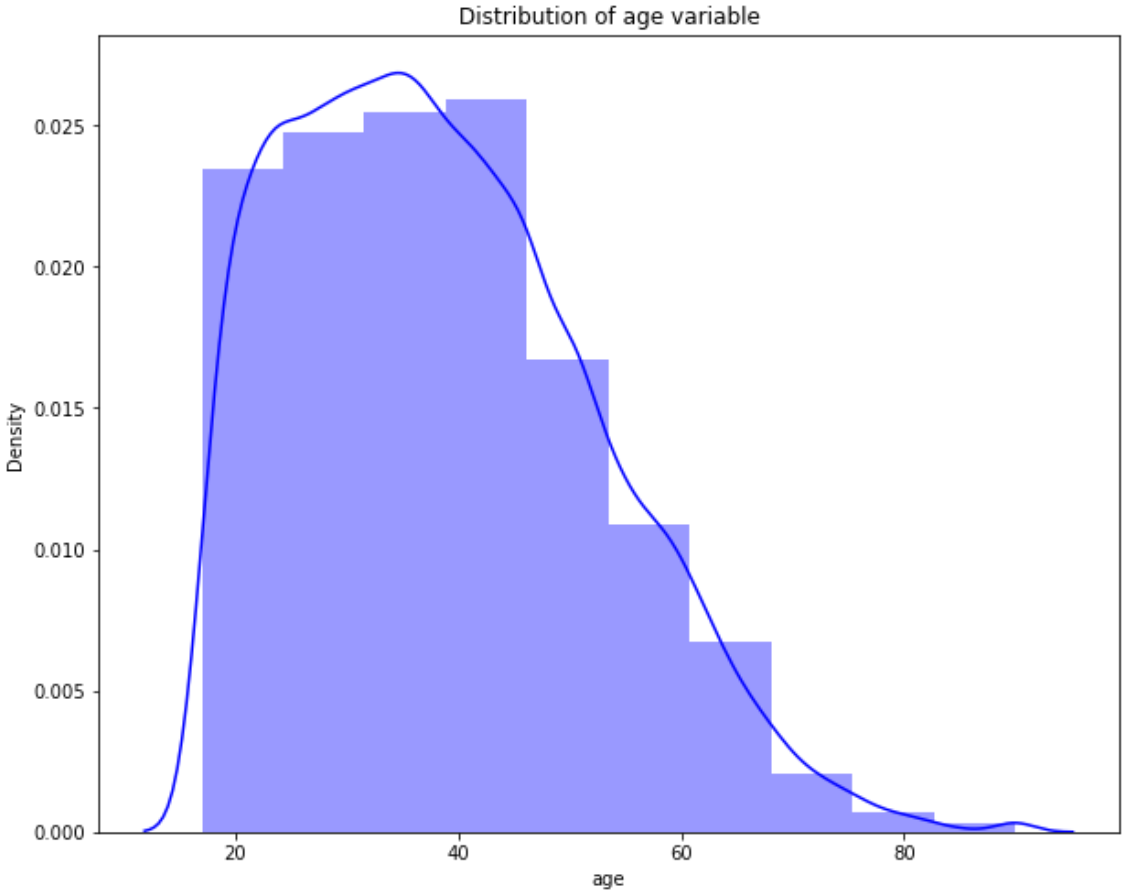
```
f, ax = plt.subplots(figsize=(10, 8))
ax = sns.countplot(x="income",  data=data, hue="sex", palette="Set1")
ax.set_title("Frequency distribution of income variable wrt sex")
plt.show()
```



In [6]:

```
f, ax = plt.subplots(figsize=(10,8))
x = data['age']
ax = sns.distplot(x, bins=10, color='blue')
ax.set_title("Distribution of age variable")
plt.show()
```

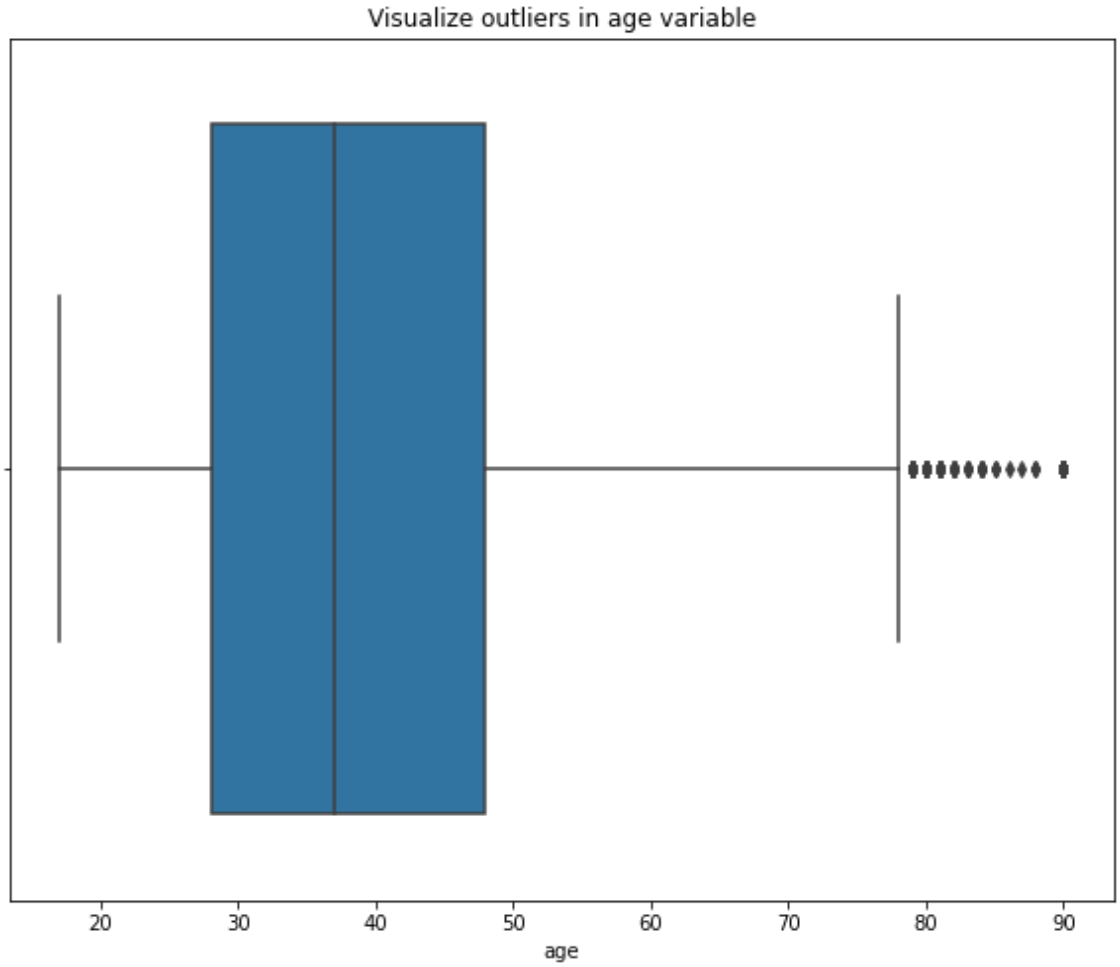
```
/home/aidar/anaconda3/lib/python3.7/site-packages/seaborn/distribution
s.py:2551: FutureWarning: `distplot` is a deprecated function and will
be removed in a future version. Please adapt your code to use either `d
isplot` (a figure-level function with similar flexibility) or `histplot
` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [7]:

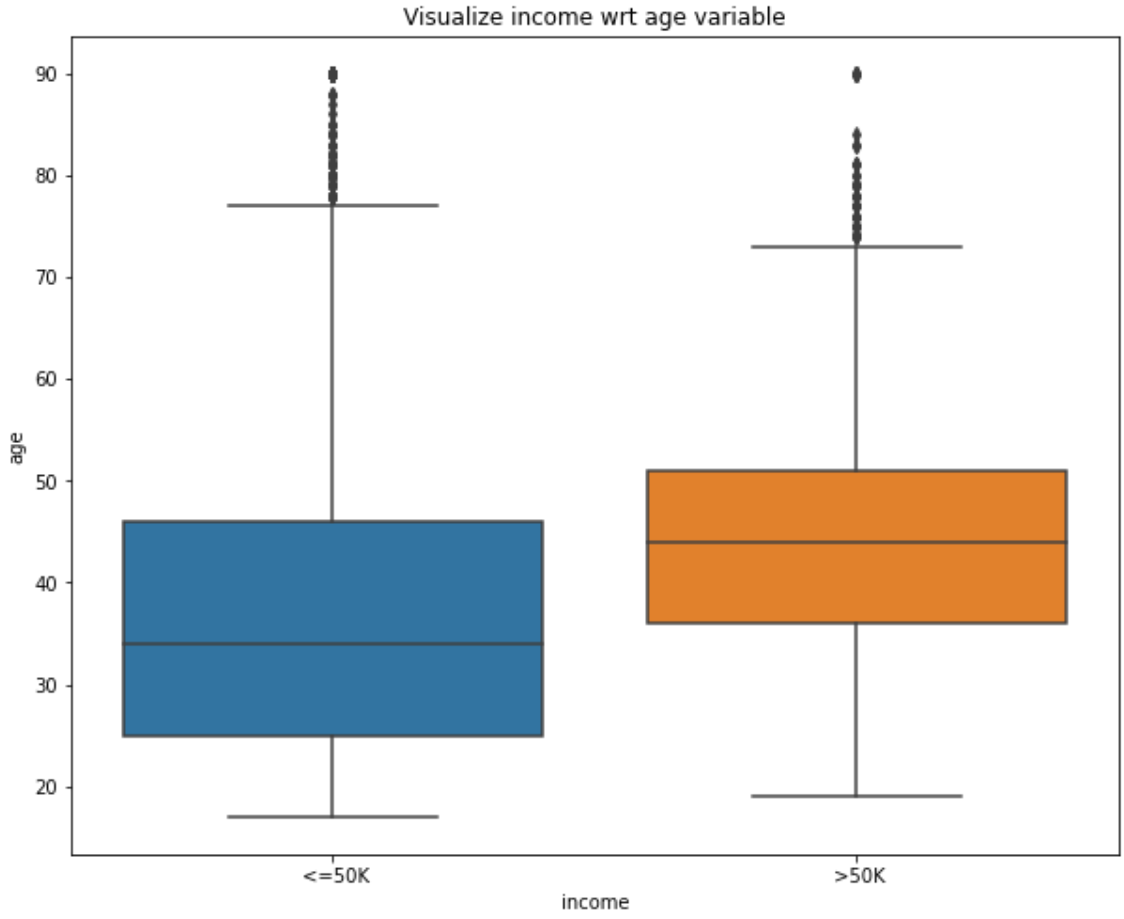
```
f, ax = plt.subplots(figsize=(10,8))
x = data['age']
ax = sns.boxplot(x)
ax.set_title("Visualize outliers in age variable")
plt.show()
```

```
/home/aidar/anaconda3/lib/python3.7/site-packages/seaborn/_decorators.p
y:43: FutureWarning: Pass the following variable as a keyword arg: x. F
rom version 0.12, the only valid positional argument will be `data`, an
d passing other arguments without an explicit keyword will result in an
error or misinterpretation.
  FutureWarning
```



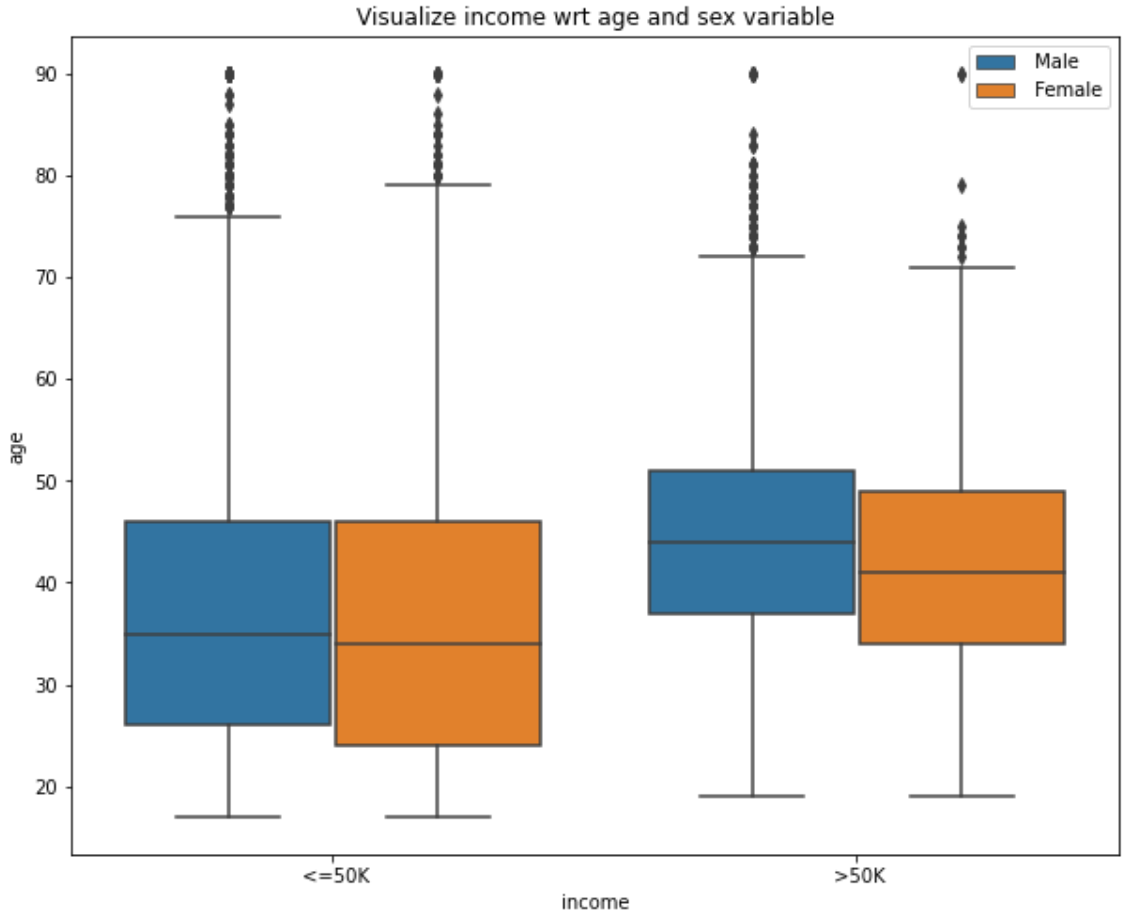
In [8]:

```
f, ax = plt.subplots(figsize=(10, 8))
ax = sns.boxplot(x="income", y="age", data=data)
ax.set_title("Visualize income wrt age variable")
plt.show()
```



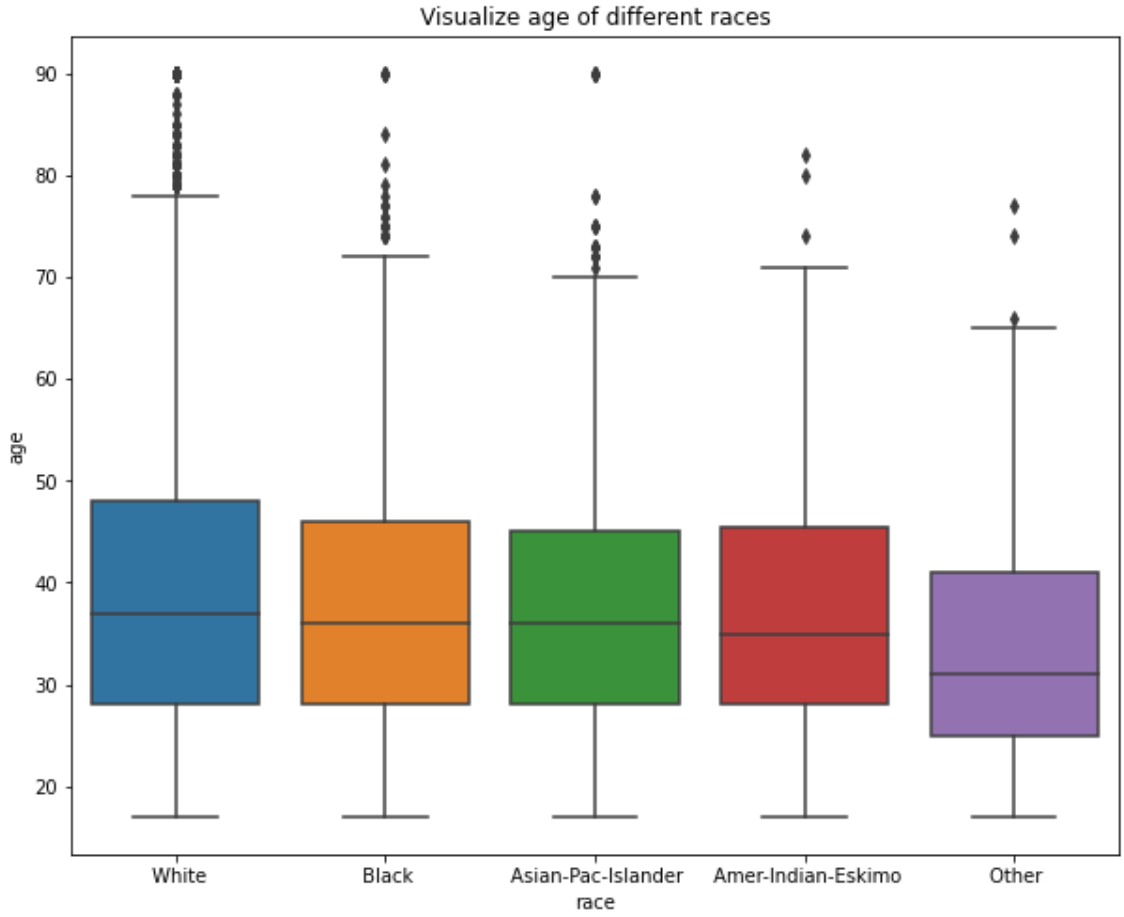
In [9]:

```
f, ax = plt.subplots(figsize=(10, 8))
ax = sns.boxplot(x="income", y="age", hue="sex", data=data)
ax.set_title("Visualize income wrt age and sex variable")
ax.legend(loc='upper right')
plt.show()
```



In [10]:

```
f, ax = plt.subplots(figsize=(10, 8))
ax = sns.boxplot(x="race", y="age", data=data)
ax.set_title("Visualize age of different races")
plt.show()
```



In [11]:

```
data.corr().style.format("{:.4}").background_gradient(cmap=plt.get_cmap('coolwarm'),
axis=1)
```

Out[11]:

	age	fnlwgt	education_num	capital_gain	capital_loss
age	1.0	-0.07665	0.03653	0.07767	0.05777
fnlwgt	-0.07665	1.0	-0.04319	0.0004319	-0.01025
education_num	0.03653	-0.04319	1.0	0.1226	0.07992
capital_gain	0.07767	0.0004319	0.1226	1.0	-0.03162
capital_loss	0.05777	-0.01025	0.07992	-0.03162	1.0
hours_per_week	0.06876	-0.01877	0.1481	0.07841	0.05426

In [12]:

```
data.replace(' ?', np.NaN, inplace=True)
```

In [13]:

```
categorical = [var for var in data.columns if data[var].dtype=='O']
data.head()
```

Out[13]:

	age	workclass	fnlwgt	education	education_num	marital_status	occupatio
0	39	State-gov	77516	Bachelors	13	Never-married	Adm-clerica
1	50	Self-emp-not-inc	83311	Bachelors	13	Married-civ-spouse	Exec manageria
2	38	Private	215646	HS-grad	9	Divorced	Handlers cleaner
3	53	Private	234721	11th	7	Married-civ-spouse	Handlers cleaner
4	28	Private	338409	Bachelors	13	Married-civ-spouse	Pro specialt

In [14]:

```
y = pd.get_dummies(data.income).iloc[:,1]
te = TargetEncoder(return_df=True)
newData = te.fit_transform(data[categorical],y)
for i in categorical:
    data[i] = newData[i]
data.head()
```

```
/home/aidar/anaconda3/lib/python3.7/site-packages/category_encoders/uti
ls.py:21: FutureWarning: is_categorical is deprecated and will be remov
ed in a future version.  Use is_categorical_dtype instead
  elif pd.api.types.is_categorical(cols):
```

Out[14]:

	age	workclass	fnlwgt	education	education_num	marital_status	occupatio
0	39	0.271957	77516	0.414753	13	0.045961	0.13448
1	50	0.284927	83311	0.414753	13	0.446848	0.48401
2	38	0.218673	215646	0.159509	9	0.104209	0.06277
3	53	0.218673	234721	0.051064	7	0.446848	0.06277
4	28	0.218673	338409	0.414753	13	0.446848	0.44903

In [15]:

```
X = data.iloc[:,:-1]
y = data.iloc[:,-1]
X_train, X_test, y_train, y_test  = train_test_split(X,y,test_size =0.3, shuffle = True)
```

Модель решающих деревьев

In [17]:

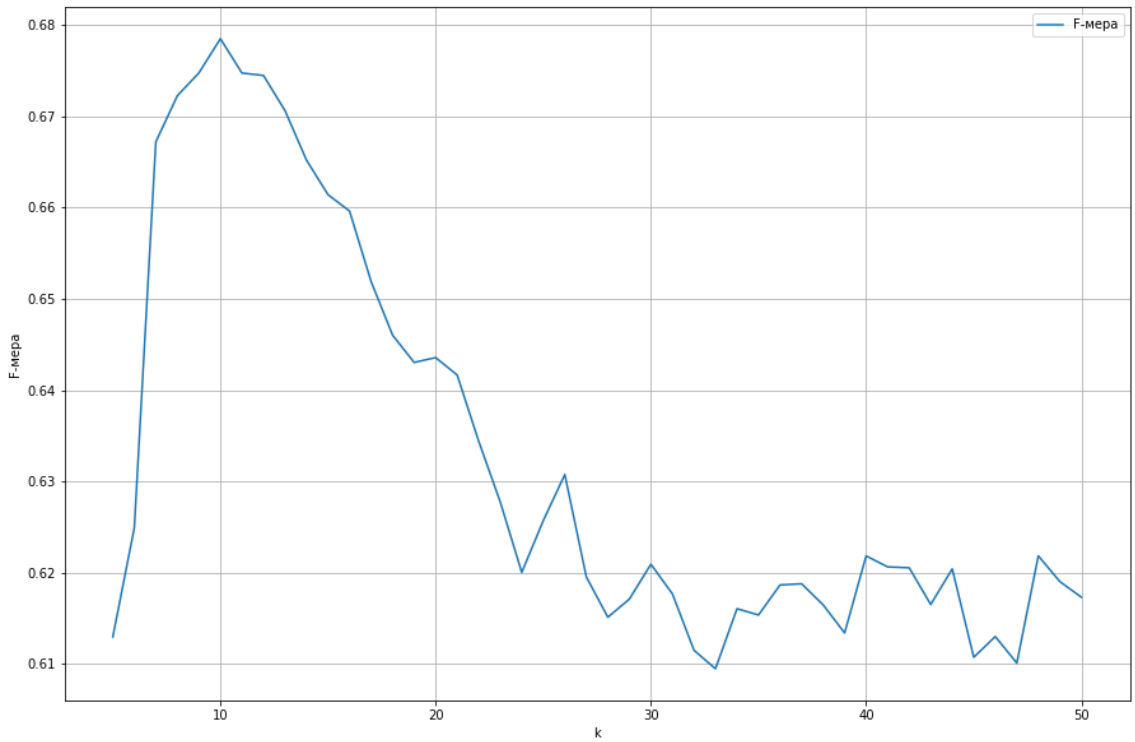
```
kf = KFold(n_splits=5,shuffle=True)
score = []
accuracy = []
for k in range(5,51):
    clf = DecisionTreeClassifier(random_state=241,max_depth=k)
    score = cross_val_score(clf, X,y, cv=kf, scoring = "f1")
    accuracy.append(score.mean())
```

In [18]:

```
depth = range(5,51)
plt.figure(figsize = [15,10])
plt.plot(depth,accuracy)
plt.grid("on")
plt.xlabel('k')
plt.ylabel('F-мера')
plt.legend(["F-мера"])
```

Out[18]:

```
<matplotlib.legend.Legend at 0x7f2b21b1f890>
```



In [19]:

```
maxF = max(accuracy)
maxInd = accuracy.index(maxF)
print("Максимально езначение F-меры %f, достигается при depth = %d" %(maxF, 5+maxInd
))
```

```
Максимально езначение F-меры 0.678465, достигается при depth = 10
```

In [21]:

```
clf = DecisionTreeClassifier(random_state=241,max_depth=10)
clf = clf.fit(X_train, y_train)
```

In [22]:

```
confusion_matrix1 = confusion_matrix(y_test, clf.predict(X_test))
pd.DataFrame(data  =  confusion_matrix1,  columns  =  ['predicted >50',
'predicted <50'], index = ['actual >50', 'actual <50'])
```

Out[22]:

	predicted >50	predicted <50
actual >50	6916	485
actual <50	898	1470

Модель случайного леса

In [23]:

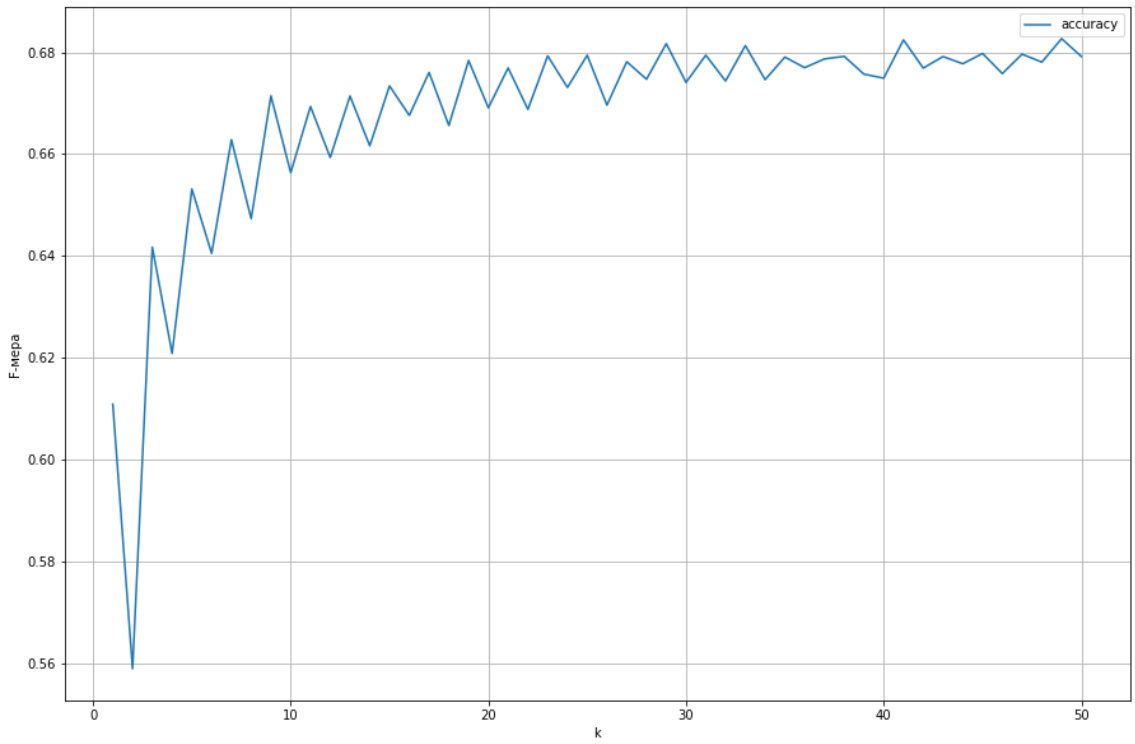
```
kf = KFold(n_splits=5,shuffle=True)
score = []
accuracy = []
for k in range(1,51):
    clf = RandomForestClassifier(random_state=241,n_estimators=k)
    score = cross_val_score(clf, X,y, cv=kf, scoring = "f1")
    accuracy.append(score.mean())
```

In [24]:

```
n_estim = range(1,51)
plt.figure(figsize = [15,10])
plt.plot(n_estim,accuracy)
plt.grid("on")
plt.xlabel('k')
plt.ylabel('F-мера')
plt.legend(["accuracy"])
```

Out[24]:

<matplotlib.legend.Legend at 0x7f2b2204e2d0>



In [25]:

```
maxF = max(accuracy)
maxInd = accuracy.index(maxF)
print("Максимально езначение F-меры %f, достигается при depth = %d" %(maxF, maxInd))
```

```
Максимально езначение F-меры 0.682652, достигается при depth = 48
```

In [26]:

```
clf = RandomForestClassifier(random_state=241,n_estimators=48)
clf = clf.fit(X_train, y_train)
```

In [27]:

```
confusion_matrix1 = confusion_matrix(y_test, clf.predict(X_test))
pd.DataFrame(data  =  confusion_matrix1,  columns  =  ['predicted >50',
'predicted <50'], index = ['actual >50', 'actual <50'])
```

Out[27]:

	predicted >50	predicted <50
actual >50	6855	546
actual <50	865	1503

In [28]:

```
from sklearn.metrics import accuracy_score
print("Accuracy = %f"%accuracy_score(y_test, clf.predict(X_test)))
```

```
Accuracy = 0.855564
```

Модель градиентного бустинга над решающими деревьями

In [29]:

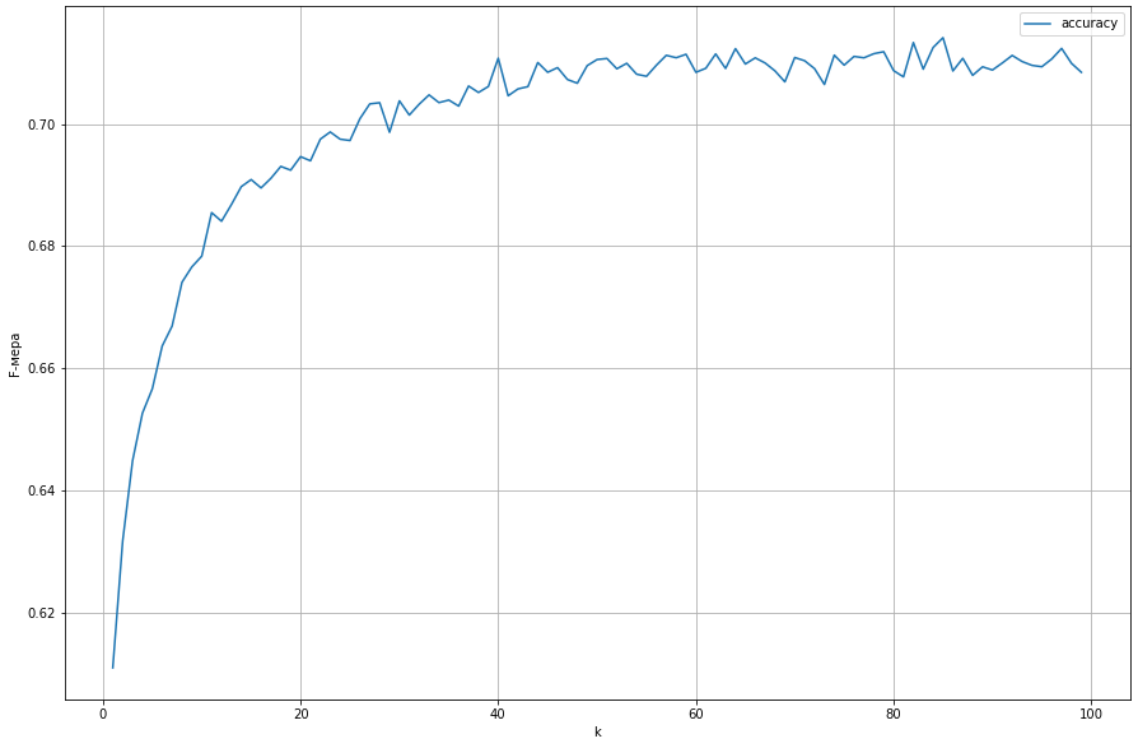
```
kf = KFold(n_splits=5,shuffle=True)
score = []
accuracy = []
for k in range(1,100):
    model = CatBoostClassifier(n_estimators = k,loss_function='Logloss', verbose =Fa
lse)
    score = cross_val_score(model, X,y, cv=kf, scoring = "f1")
    accuracy.append(score.mean())
```

In [30]:

```
n_estim = range(1,100)
plt.figure(figsize = [15,10])
plt.plot(n_estim,accuracy)
plt.grid("on")
plt.xlabel('k')
plt.ylabel('F-мера')
plt.legend(["accuracy"])
```

Out[30]:

```
<matplotlib.legend.Legend at 0x7f2b209c2e50>
```



In [31]:

```
maxF = max(accuracy)
maxInd = accuracy.index(maxF)
print("Максимально езначение F-меры %f, достигается при n_estimators = %d" %(maxF, m
axInd))
```

```
Максимально езначение F-меры 0.714129, достигается при n_estimators = 8
4
```

In [32]:

```
clf = CatBoostClassifier(random_state=241,n_estimators=maxInd, verbose = False)
clf = clf.fit(X_train, y_train)
```

In [33]:

```
confusion_matrix1 = confusion_matrix(y_test, clf.predict(X_test))
pd.DataFrame(data  =  confusion_matrix1,  columns  =  ['predicted >50',
'predicted <50'], index = ['actual >50', 'actual <50'])
```

Out[33]:

	predicted >50	predicted <50
actual >50	6947	454
actual <50	808	1560

In [34]:

```
from sklearn.metrics import accuracy_score
print("Accuracy = %f"%accuracy_score(y_test, clf.predict(X_test)))
```

Accuracy = 0.870816

Вывод по применению алгоритмов на основе решающих деревьев

Решаюшие деревья

Оптимальным значением глубины решающего дерева является значеение = 10, при этом F-мера = 0.678465

Случайный лес

Оптимальным значением количества решающих деревьев в композиции является значеение = 48, при этом F-мера = 0.682652. Данное значение хоть и улучшилось, но не значительно, а также заметно, что чем больше деревьев в композиции тем лучше

Бустинг

птимальным значением количества решающих деревьев в композиции является значеение = 84, при этом F-мера = 0.714129. Данное значение также улучшилось по сравнению со случайным лесом

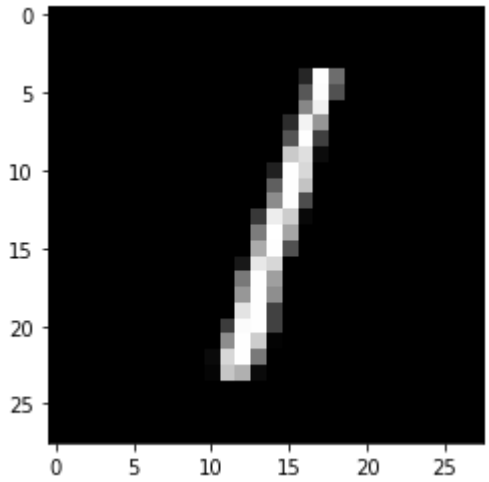
Модель нейронной сети для MNIST набора данных

In [4]:

```
from tensorflow.keras.datasets import mnist
(X_train, y_train), (X_test, y_test) = mnist.load_data()
```

In [5]:

```
sample = 100
image = X_test[2]
fig = plt.figure
plt.imshow(image, cmap='gray')
plt.show()
```



In [6]:

```
X_train = X_train.reshape(X_train.shape[0], 28*28)
X_test = X_test.reshape(X_test.shape[0], 28*28)
```

In [7]:

```
y_train = np_utils.to_categorical(y_train, 10)
y_test = np_utils.to_categorical(y_test, 10)
```

In [8]:

```
NB_CLASSES = y_train.shape[1]
INPUT_SHAPE = (X_train.shape[1],)
model = Sequential()
model.add(Dense(32, input_shape=INPUT_SHAPE))
model.add(Activation('relu'))
model.add(Dropout(0.3))
model.add(Dense(16))
model.add(Activation('relu'))
model.add(Dense(8))
model.add(Activation('relu'))
model.add(Dense(NB_CLASSES))
model.add(Activation('softmax'))
model.summary()

model.compile(loss='categorical_crossentropy',
    optimizer = 'adam',
    metrics=['accuracy','Precision', 'Recall'])
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 32)                25120
_________________________________________________________________
activation (Activation)      (None, 32)                0
_________________________________________________________________
dropout (Dropout)            (None, 32)                0
_________________________________________________________________
dense_1 (Dense)              (None, 16)                528
_________________________________________________________________
activation_1 (Activation)    (None, 16)                0
_________________________________________________________________
dense_2 (Dense)              (None, 8)                 136
_________________________________________________________________
activation_2 (Activation)    (None, 8)                 0
_________________________________________________________________
dense_3 (Dense)              (None, 10)                90
_________________________________________________________________
activation_3 (Activation)    (None, 10)                0
=================================================================
Total params: 25,874
Trainable params: 25,874
Non-trainable params: 0
_________________________________________________________________
```

In [9]:

```
%%time
EPOCHS = 30
history = model.fit(X_train, y_train,
                    batch_size = 128, epochs = EPOCHS,
                    verbose = 0, validation_data = (X_test, y_test))
```

```
WARNING:tensorflow:From /home/aidar/anaconda3/lib/python3.7/site-packag
es/tensorflow/python/ops/resource_variable_ops.py:1817: calling BaseRes
ourceVariable.__init__ (from tensorflow.python.ops.resource_variable_op
s) with constraint is deprecated and will be removed in a future versio
n.
Instructions for updating:
If using Keras pass *_constraint arguments to layers.
CPU times: user 1min 28s, sys: 13.7 s, total: 1min 42s
Wall time: 44 s
```

In [13]:

```
history.history['accuracy']
```

Out[13]:

```
[0.14206667244434357,
 0.2011999934911728,
 0.29963332414627075,
 0.4392833411693573,
 0.5447166562080383,
 0.6500833630561829,
 0.6969333291053772,
 0.7103999853134155,
 0.7283166646957397,
 0.753166675567627,
 0.7675333619117737,
 0.7810999751091003,
 0.7890833616256714,
 0.7982000112533569,
 0.8046166896820068,
 0.8112499713897705,
 0.8132833242416382,
 0.8172833323478699,
 0.8205833435058594,
 0.8268333077430725,
 0.8285833597183228,
 0.8288999795913696,
 0.8355166912078857,
 0.8353000283241272,
 0.8407166600227356,
 0.8430500030517578,
 0.8448666930198669,
 0.8495333194732666,
 0.8514000177383423,
 0.854283332824707]
```

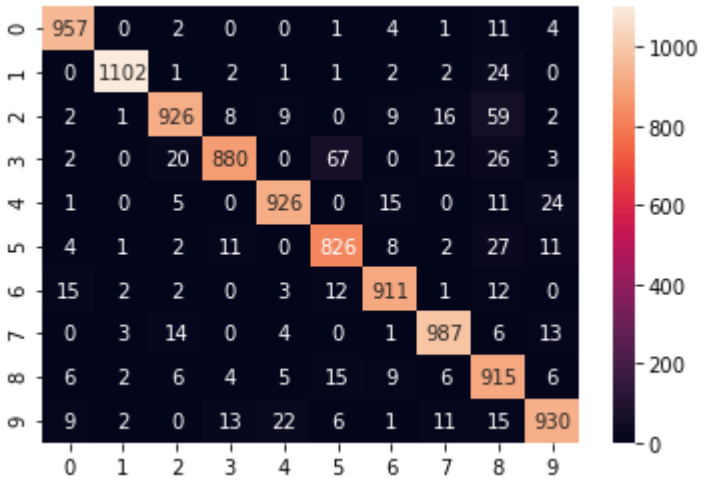
In [211]:

```
y_pred = model.predict_classes(X_test)
print(y_pred[2])
```

1

In [215]:

```
confusion_matrix_ = confusion_matrix(np.argmax(y_test,axis=-1), y_pred)
cm = pd.DataFrame(data = confusion_matrix_, columns = ['0', '1', '2', '3', '4',
'5', '6', '7', '8', '9'], index = ['0', '1', '2', '3', '4', '5', '6', '7', '8', '9'
])
ax = sns.heatmap(cm, annot=True, fmt="d")
```



Вывод по созданию нейронной сети для определения рукописных цифр

Для решения данной задачи была составлена модель нейронной сети - многослойный перцептрон. Сеть состоит из 4 слоев нейронов. Данная модель показывает хорошее качество по угадыванию цифр, что видно на матрице ошибок.

In [ ]:

```
```

In [6]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from category_encoders import TargetEncoder
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.metrics import confusion_matrix
from sklearn.preprocessing import StandardScaler
from tensorflow.python.keras.utils import np_utils
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Activation, Dropout,BatchNormalization
from tensorflow import keras
from tensorflow.keras import regularizers
from sklearn.preprocessing import OneHotEncoder
```

In [2]:

```
data1 = pd.read_csv('income.csv')
data1.head()
```

Out[2]:

	age	workclass	fnlwgt	education	education_num	marital_status	occupatio
0	39	State-gov	77516	Bachelors	13	Never-married	Adm-clerica
1	50	Self-emp-not-inc	83311	Bachelors	13	Married-civ-spouse	Exec manageria
2	38	Private	215646	HS-grad	9	Divorced	Handlers cleaner
3	53	Private	234721	11th	7	Married-civ-spouse	Handlers cleaner
4	28	Private	338409	Bachelors	13	Married-civ-spouse	Pro specialt

In [3]:

```
data1.replace(' ?', np.NaN, inplace=True)
```

In [4]:

```
categorical = [var for var in data1.columns if data1[var].dtype=='O']
y = pd.get_dummies(data1.income).iloc[:,1]
```

In [5]:

```
categorical
```

Out[5]:

```
['workclass',
 'education',
 'marital_status',
 'occupation',
 'relationship',
 'race',
 'sex',
 'native_country',
 'income']
```

TargetEncoding

In [6]:

```
te = TargetEncoder(return_df=True)
newData = te.fit_transform(data1[categorical],y)
for i in categorical:
    data1[i] = newData[i]
data1.head()
```

```
/home/aidar/anaconda3/lib/python3.7/site-packages/category_encoders/uti
ls.py:21: FutureWarning: is_categorical is deprecated and will be remov
ed in a future version.  Use is_categorical_dtype instead
  elif pd.api.types.is_categorical(cols):
```

Out[6]:

	age	workclass	fnlwgt	education	education_num	marital_status	occupatio
0	39	0.271957	77516	0.414753	13	0.045961	0.13448
1	50	0.284927	83311	0.414753	13	0.446848	0.48401
2	38	0.218673	215646	0.159509	9	0.104209	0.06277
3	53	0.218673	234721	0.051064	7	0.446848	0.06277
4	28	0.218673	338409	0.414753	13	0.446848	0.44903

In [7]:

```
X = data1.iloc[:,:-1]
y = data1.iloc[:,-1]
# X_train, X_test, y_train, y_test  = train_test_split(X,y,test_size =0.3, shuffle =
True)
```

LabelEncoding

In [14]:

```
data = pd.read_csv('income.csv')
data.head()
```

Out[14]:

	age	workclass	fnlwgt	education	education_num	marital_status	occupatio
0	39	State-gov	77516	Bachelors	13	Never-married	Adm-clerica
1	50	Self-emp-not-inc	83311	Bachelors	13	Married-civ-spouse	Exec manageria
2	38	Private	215646	HS-grad	9	Divorced	Handlers cleaner
3	53	Private	234721	11th	7	Married-civ-spouse	Handlers cleaner
4	28	Private	338409	Bachelors	13	Married-civ-spouse	Pro specialt

In [16]:

```
le = LabelEncoder()
for i in categorical[:]:
    data[i] = le.fit_transform(data[i].astype(str))
data.shape
```

Out[16]:

```
(32561, 15)
```

OneHotEncoding

In [118]:

```
data_One = pd.read_csv('income.csv')
```

In [119]:

```
categoricalData = data_One[categorical]
categoricalData.head()
```

Out[119]:

	workclass	education	marital_status	occupation	relationship	race	sex
0	State-gov	Bachelors	Never-married	Adm-clerical	Not-in-family	White	Male
1	Self-emp-not-inc	Bachelors	Married-civ-spouse	Exec-managerial	Husband	White	Male
2	Private	HS-grad	Divorced	Handlers-cleaners	Not-in-family	White	Male
3	Private	11th	Married-civ-spouse	Handlers-cleaners	Husband	Black	Male
4	Private	Bachelors	Married-civ-spouse	Prof-specialty	Wife	Black	Female

In [120]:

```
one_hot_encoder = OneHotEncoder(sparse=False)

y = data_One.iloc[:,-1]

data_One.drop("income", axis='columns', inplace=True)

for i in categorical[:-1]:
    dataToInsert = pd.DataFrame(one_hot_encoder.fit_transform(data_One[i].astype(str
).values.reshape(-1,1)),
                                columns = one_hot_encoder.categories_)
    data_One = pd.concat([data_One,dataToInsert],axis =1)

data_One.drop(categorical[:-1], axis='columns', inplace=True)

data_One = pd.concat([data_One,y],axis =1)
data_One.head()
```

Out[120]:

	age	fnlwgt	education_num	capital_gain	capital_loss	hours_per_week	(?,)
0	39	77516	13	2174	0	40	0.0
1	50	83311	13	0	0	13	0.0
2	38	215646	9	0	0	40	0.0
3	53	234721	7	0	0	40	0.0
4	28	338409	13	0	0	40	0.0

5 rows × 109 columns

In [112]:

```
def prepareData(data):
    X = data.iloc[:,:-1]
    y = data.iloc[:,-1]

    from sklearn.preprocessing import MinMaxScaler

    scaler = MinMaxScaler(feature_range=(0,1))
    scaler.fit(X)
    X = scaler.transform(X)
#     scaler = StandardScaler()
#     X = scaler.fit_transform(X)
#     print(scaler.mean_)

    X_train, X_test, y_train, y_test  = train_test_split(X,y,test_size =0.3, shuffle
= True)

    X_train = X_train.astype(np.float32)
    X_test = X_test.astype(np.float32)
    y_train = pd.get_dummies(y_train)
    y_test = pd.get_dummies(y_test)
#     y_train = np_utils.to_categorical(y_train_l, 2)
#     y_test = np_utils.to_categorical(y_test_l, 2)
    return X_train, X_test, y_train, y_test
```

In [113]:

```
 def createModel(X_train,y_train):
    NB_CLASSES = y_train.shape[1]
    INPUT_SHAPE = (X_train.shape[1],)
    model = Sequential()
    model.add(Dense(32, input_shape=INPUT_SHAPE))
    model.add(Activation('relu'))
    model.add(Dense(16))
    model.add(Activation('relu'))
    model.add(Dense(8))
    model.add(Activation('relu'))
    model.add(Dense(NB_CLASSES))
    model.add(Activation('softmax'))
    model.summary()
    return model
```

In [114]:

```
def modelLearning(X_train,X_test,y_train,y_test, model,BATCH,EPOCHS = 30):

    hist = model.fit(X_train, y_train, batch_size = BATCH, epochs = EPOCHS,
                         verbose = 1, validation_data = (X_test, y_test))
    return hist
```

In [115]:

```
def getFScore(history):
    f1_score_list_train = []
    f1_score_list_test = []
    for i in range(30):
        f1_score_list_train.append(2* history.history["precision"][i]*history.histor
y['recall'][i]/
                                   (history.history["precision"][i]+history.history['rec
all'][i]))
        f1_score_list_test.append(2*history.history['val_precision'][i]*history.hist
ory['val_recall'][i]/
                                  (history.history['val_precision'][i]+history.history[
'val_recall'][i]))
    return f1_score_list_train, f1_score_list_test
```

TargetEncoding

In [14]:

```
data1.head()
```

Out[14]:

	age	workclass	fnlwgt	education	education_num	marital_status	occupatio
0	39	0.271957	77516	0.414753	13	0.045961	0.13448
1	50	0.284927	83311	0.414753	13	0.446848	0.48401
2	38	0.218673	215646	0.159509	9	0.104209	0.06277
3	53	0.218673	234721	0.051064	7	0.446848	0.06277
4	28	0.218673	338409	0.414753	13	0.446848	0.44903

In [15]:

```
X_train_t,X_test_t,y_train_t,y_test_t = prepareData(data1)
```

In [16]:

```
model_t = createModel(X_train_t,y_train_t)
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 32)                480
_________________________________________________________________
activation (Activation)      (None, 32)                0
_________________________________________________________________
dense_1 (Dense)              (None, 16)                528
_________________________________________________________________
activation_1 (Activation)    (None, 16)                0
_________________________________________________________________
dense_2 (Dense)              (None, 8)                 136
_________________________________________________________________
activation_2 (Activation)    (None, 8)                 0
_________________________________________________________________
dense_3 (Dense)              (None, 2)                 18
_________________________________________________________________
activation_3 (Activation)    (None, 2)                 0
=================================================================
Total params: 1,162
Trainable params: 1,162
Non-trainable params: 0
_________________________________________________________________
```

In [17]:

```
model_t.compile(loss='binary_crossentropy',
              optimizer = 'adam',
              metrics=["accuracy",'Precision', 'Recall'])
```

In [18]:

```
history_t = modelLearning(X_train_t,X_test_t,y_train_t,y_test_t,model_t,128)
```

```
Epoch 1/30
WARNING:tensorflow:From /home/aidar/anaconda3/lib/python3.7/site-packag
es/tensorflow/python/ops/resource_variable_ops.py:1817: calling BaseRes
ourceVariable.__init__ (from tensorflow.python.ops.resource_variable_op
s) with constraint is deprecated and will be removed in a future versio
n.
Instructions for updating:
If using Keras pass *_constraint arguments to layers.
179/179 [==============================] - 1s 5ms/step - loss: 0.4560 -
accuracy: 0.7577 - precision: 0.7576 - recall: 0.7569 - val_loss: 0.396
2 - val_accuracy: 0.7565 - val_precision: 0.7565 - val_recall: 0.7565
Epoch 2/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3801 -
accuracy: 0.8171 - precision: 0.8171 - recall: 0.8171 - val_loss: 0.372
3 - val_accuracy: 0.8357 - val_precision: 0.8357 - val_recall: 0.8357
Epoch 3/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3654 -
accuracy: 0.8335 - precision: 0.8335 - recall: 0.8335 - val_loss: 0.359
3 - val_accuracy: 0.8394 - val_precision: 0.8394 - val_recall: 0.8394
Epoch 4/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3526 -
accuracy: 0.8387 - precision: 0.8387 - recall: 0.8387 - val_loss: 0.351
4 - val_accuracy: 0.8415 - val_precision: 0.8415 - val_recall: 0.8415
Epoch 5/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3458 -
accuracy: 0.8410 - precision: 0.8410 - recall: 0.8410 - val_loss: 0.344
6 - val_accuracy: 0.8467 - val_precision: 0.8467 - val_recall: 0.8467
Epoch 6/30
 62/179 [=========>....................] - ETA: 0s - loss: 0.3406 - acc
uracy: 0.8435 - precision: 0.8435 - recall: 0.8435
```

```
---------------------------------------------------------------------
----
KeyboardInterrupt                         Traceback (most recent call l
ast)
<ipython-input-18-f8470fd1941b> in <module>
----> 1 history_t = modelLearning(X_train_t,X_test_t,y_train_t,y_test_t
,model_t,128)

<ipython-input-12-9cceab7f25c3> in modelLearning(X_train, X_test, y_tra
in, y_test, model, BATCH, EPOCHS)
      2
      3     hist = model.fit(X_train, y_train, batch_size = BATCH, epoc
hs = EPOCHS,
----> 4                      verbose = 1, validation_data = (X_test,
y_test))
      5     return hist

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/keras/engine/
training.py in _method_wrapper(self, *args, **kwargs)
     64   def _method_wrapper(self, *args, **kwargs):
     65     if not self._in_multi_worker_mode():  # pylint: disable=pro
tected-access
---> 66       return method(self, *args, **kwargs)
     67
     68     # Running inside `run_distribute_coordinator` already.

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/keras/engine/
training.py in fit(self, x, y, batch_size, epochs, verbose, callbacks,
 validation_split, validation_data, shuffle, class_weight, sample_weigh
t, initial_epoch, steps_per_epoch, validation_steps, validation_batch_s
ize, validation_freq, max_queue_size, workers, use_multiprocessing)
    846                 batch_size=batch_size):
    847               callbacks.on_train_batch_begin(step)
--> 848               tmp_logs = train_function(iterator)
    849               # Catch OutOfRangeError for Datasets of unknown s
ize.
    850               # This blocks until the batch has finished execut
ing.

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/eager/def_fun
ction.py in __call__(self, *args, **kwds)
    578         xla_context.Exit()
    579     else:
--> 580       result = self._call(*args, **kwds)
    581
    582     if tracing_count == self._get_tracing_count():

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/eager/def_fun
ction.py in _call(self, *args, **kwds)
    609       # In this case we have created variables on the first cal
l, so we run the
    610       # defunned version which is guaranteed to never create va
riables.
--> 611       return self._stateless_fn(*args, **kwds)  # pylint: disab
le=not-callable
    612     elif self._stateful_fn is not None:
    613       # Release the lock early so that multiple threads can per
```

```
form the call

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/eager/functio
n.py in __call__(self, *args, **kwargs)
   2418     with self._lock:
   2419       graph_function, args, kwargs = self._maybe_define_functio
n(args, kwargs)
-> 2420     return graph_function._filtered_call(args, kwargs)  # pylin
t: disable=protected-access
   2421
   2422   @property

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/eager/functio
n.py in _filtered_call(self, args, kwargs)
   1663          if isinstance(t, (ops.Tensor,
   1664                            resource_variable_ops.BaseResourceVa
riable))),
-> 1665         self.captured_inputs)
   1666
   1667   def _call_flat(self, args, captured_inputs, cancellation_mana
ger=None):

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/eager/functio
n.py in _call_flat(self, args, captured_inputs, cancellation_manager)
   1744       # No tape is watching; skip to running the function.
   1745       return self._build_call_outputs(self._inference_function.
call(
-> 1746           ctx, args, cancellation_manager=cancellation_manage
r))
   1747     forward_backward = self._select_forward_and_backward_functi
ons(
   1748         args,

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/eager/functio
n.py in call(self, ctx, args, cancellation_manager)
    596               inputs=args,
    597               attrs=attrs,
--> 598               ctx=ctx)
    599         else:
    600           outputs = execute.execute_with_cancellation(

~/anaconda3/lib/python3.7/site-packages/tensorflow/python/eager/execut
e.py in quick_execute(op_name, num_outputs, inputs, attrs, ctx, name)
     58     ctx.ensure_initialized()
     59     tensors = pywrap_tfe.TFE_Py_Execute(ctx._handle, device_nam
e, op_name,
---> 60                                         inputs, attrs, num_outp
uts)
     61   except core._NotOkStatusException as e:
     62     if name is not None:

KeyboardInterrupt:
```

In [ ]:

```
model_t.evaluate(X_test_t,y_test_t)
```

LabelEncoding

In [131]:

```
X_train_l,X_test_l,y_train_l,y_test_l = prepareData(data)
```

In [33]:

```
model_l = createModel(X_train_l,y_train_l)
```

```
Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
dense_8 (Dense)              (None, 32)                480       
_________________________________________________________________
activation_8 (Activation)    (None, 32)                0         
_________________________________________________________________
dense_9 (Dense)              (None, 16)                528       
_________________________________________________________________
activation_9 (Activation)    (None, 16)                0         
_________________________________________________________________
dense_10 (Dense)             (None, 8)                 136       
_________________________________________________________________
activation_10 (Activation)   (None, 8)                 0         
_________________________________________________________________
dense_11 (Dense)             (None, 2)                 18        
_________________________________________________________________
activation_11 (Activation)   (None, 2)                 0         
=================================================================
Total params: 1,162
Trainable params: 1,162
Non-trainable params: 0
_________________________________________________________________
```

In [34]:

```
model_l.compile(loss='binary_crossentropy',
              optimizer = 'adam',
              metrics=["accuracy",'Precision', 'Recall'])
```

In [35]:

```
history_l = modelLearning(X_train_l,X_test_l,y_train_l,y_test_l,model_l,128)
```

```
Epoch 1/30
179/179 [==============================] - 1s 7ms/step - loss: 0.4802 -
accuracy: 0.7751 - precision: 0.7751 - recall: 0.7751 - val_loss: 0.424
2 - val_accuracy: 0.8053 - val_precision: 0.8053 - val_recall: 0.8053
Epoch 2/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3905 -
accuracy: 0.8226 - precision: 0.8226 - recall: 0.8226 - val_loss: 0.379
1 - val_accuracy: 0.8231 - val_precision: 0.8231 - val_recall: 0.8231
Epoch 3/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3605 -
accuracy: 0.8335 - precision: 0.8335 - recall: 0.8335 - val_loss: 0.359
8 - val_accuracy: 0.8287 - val_precision: 0.8287 - val_recall: 0.8287
Epoch 4/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3458 -
accuracy: 0.8411 - precision: 0.8411 - recall: 0.8411 - val_loss: 0.356
4 - val_accuracy: 0.8296 - val_precision: 0.8296 - val_recall: 0.8296
Epoch 5/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3395 -
accuracy: 0.8443 - precision: 0.8443 - recall: 0.8443 - val_loss: 0.351
3 - val_accuracy: 0.8337 - val_precision: 0.8337 - val_recall: 0.8337
Epoch 6/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3355 -
accuracy: 0.8443 - precision: 0.8443 - recall: 0.8443 - val_loss: 0.362
5 - val_accuracy: 0.8296 - val_precision: 0.8296 - val_recall: 0.8296
Epoch 7/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3333 -
accuracy: 0.8464 - precision: 0.8464 - recall: 0.8464 - val_loss: 0.344
8 - val_accuracy: 0.8372 - val_precision: 0.8372 - val_recall: 0.8372
Epoch 8/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3324 -
accuracy: 0.8453 - precision: 0.8453 - recall: 0.8453 - val_loss: 0.353
3 - val_accuracy: 0.8314 - val_precision: 0.8314 - val_recall: 0.8314
Epoch 9/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3294 -
accuracy: 0.8467 - precision: 0.8467 - recall: 0.8467 - val_loss: 0.362
1 - val_accuracy: 0.8307 - val_precision: 0.8307 - val_recall: 0.8307
Epoch 10/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3289 -
accuracy: 0.8449 - precision: 0.8449 - recall: 0.8449 - val_loss: 0.337
1 - val_accuracy: 0.8383 - val_precision: 0.8383 - val_recall: 0.8383
Epoch 11/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3262 -
accuracy: 0.8481 - precision: 0.8481 - recall: 0.8481 - val_loss: 0.336
8 - val_accuracy: 0.8375 - val_precision: 0.8375 - val_recall: 0.8375
Epoch 12/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3265 -
accuracy: 0.8487 - precision: 0.8487 - recall: 0.8487 - val_loss: 0.335
5 - val_accuracy: 0.8386 - val_precision: 0.8386 - val_recall: 0.8386
Epoch 13/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3260 -
accuracy: 0.8475 - precision: 0.8475 - recall: 0.8475 - val_loss: 0.338
6 - val_accuracy: 0.8380 - val_precision: 0.8380 - val_recall: 0.8380
Epoch 14/30
179/179 [==============================] - 1s 5ms/step - loss: 0.3257 -
accuracy: 0.8478 - precision: 0.8478 - recall: 0.8478 - val_loss: 0.350
1 - val_accuracy: 0.8304 - val_precision: 0.8304 - val_recall: 0.8304
Epoch 15/30
```

```
179/179 [==============================] - 1s 4ms/step - loss: 0.3258 -
accuracy: 0.8475 - precision: 0.8475 - recall: 0.8475 - val_loss: 0.332
9 - val_accuracy: 0.8395 - val_precision: 0.8395 - val_recall: 0.8395
Epoch 16/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3230 -
accuracy: 0.8489 - precision: 0.8489 - recall: 0.8489 - val_loss: 0.337
4 - val_accuracy: 0.8368 - val_precision: 0.8368 - val_recall: 0.8368
Epoch 17/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3245 -
accuracy: 0.8482 - precision: 0.8482 - recall: 0.8482 - val_loss: 0.337
7 - val_accuracy: 0.8381 - val_precision: 0.8381 - val_recall: 0.8381
Epoch 18/30
179/179 [==============================] - 1s 5ms/step - loss: 0.3227 -
accuracy: 0.8480 - precision: 0.8480 - recall: 0.8480 - val_loss: 0.333
5 - val_accuracy: 0.8386 - val_precision: 0.8386 - val_recall: 0.8386
Epoch 19/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3231 -
accuracy: 0.8497 - precision: 0.8497 - recall: 0.8497 - val_loss: 0.335
7 - val_accuracy: 0.8382 - val_precision: 0.8382 - val_recall: 0.8382
Epoch 20/30
179/179 [==============================] - 1s 5ms/step - loss: 0.3221 -
accuracy: 0.8490 - precision: 0.8490 - recall: 0.8490 - val_loss: 0.332
7 - val_accuracy: 0.8397 - val_precision: 0.8397 - val_recall: 0.8397
Epoch 21/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3211 -
accuracy: 0.8510 - precision: 0.8510 - recall: 0.8510 - val_loss: 0.339
3 - val_accuracy: 0.8379 - val_precision: 0.8379 - val_recall: 0.8379
Epoch 22/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3211 -
accuracy: 0.8489 - precision: 0.8489 - recall: 0.8489 - val_loss: 0.338
3 - val_accuracy: 0.8363 - val_precision: 0.8363 - val_recall: 0.8363
Epoch 23/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3198 -
accuracy: 0.8501 - precision: 0.8501 - recall: 0.8501 - val_loss: 0.332
9 - val_accuracy: 0.8388 - val_precision: 0.8388 - val_recall: 0.8388
Epoch 24/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3200 -
accuracy: 0.8495 - precision: 0.8495 - recall: 0.8495 - val_loss: 0.333
4 - val_accuracy: 0.8399 - val_precision: 0.8399 - val_recall: 0.8399
Epoch 25/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3197 -
accuracy: 0.8505 - precision: 0.8505 - recall: 0.8505 - val_loss: 0.346
3 - val_accuracy: 0.8364 - val_precision: 0.8364 - val_recall: 0.8364
Epoch 26/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3200 -
accuracy: 0.8494 - precision: 0.8494 - recall: 0.8494 - val_loss: 0.332
5 - val_accuracy: 0.8408 - val_precision: 0.8408 - val_recall: 0.8408
Epoch 27/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3189 -
accuracy: 0.8506 - precision: 0.8506 - recall: 0.8506 - val_loss: 0.338
9 - val_accuracy: 0.8355 - val_precision: 0.8355 - val_recall: 0.8355
Epoch 28/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3201 -
accuracy: 0.8508 - precision: 0.8508 - recall: 0.8508 - val_loss: 0.329
6 - val_accuracy: 0.8413 - val_precision: 0.8413 - val_recall: 0.8413
Epoch 29/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3199 -
```

```
accuracy: 0.8509 - precision: 0.8509 - recall: 0.8509 - val_loss: 0.330
1 - val_accuracy: 0.8409 - val_precision: 0.8409 - val_recall: 0.8409
Epoch 30/30
179/179 [==============================] - 1s 4ms/step - loss: 0.3183 -
accuracy: 0.8522 - precision: 0.8522 - recall: 0.8522 - val_loss: 0.335
4 - val_accuracy: 0.8398 - val_precision: 0.8398 - val_recall: 0.8398
```

In [36]:

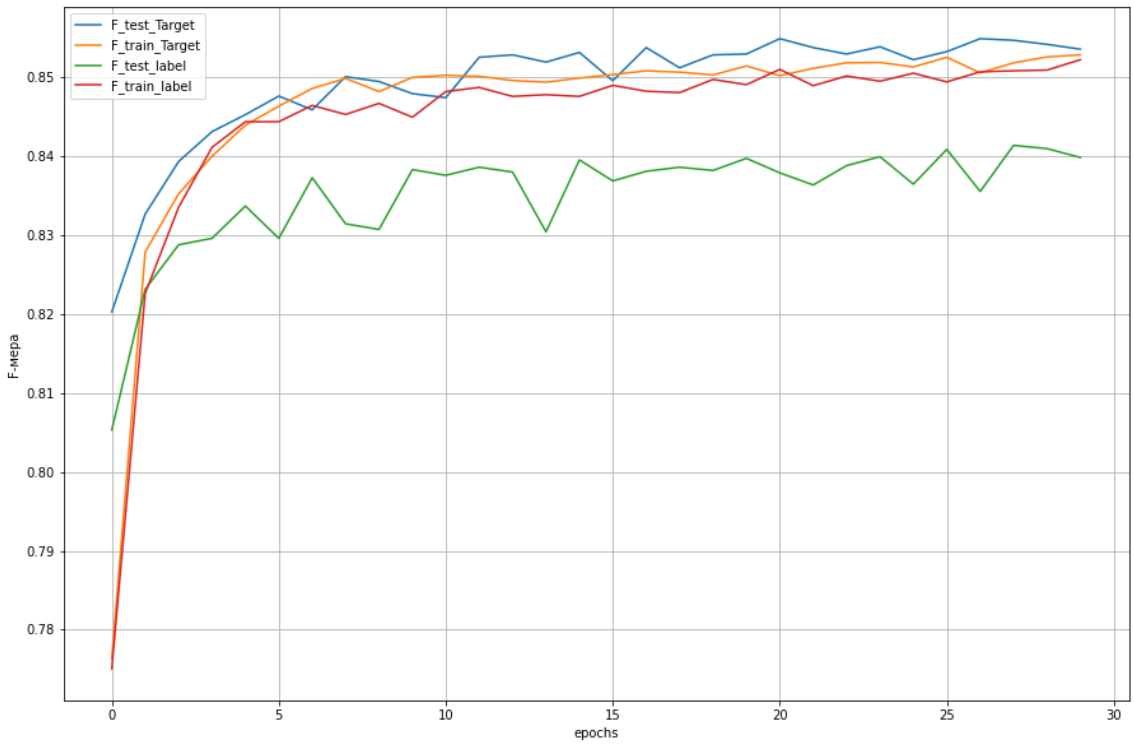
```
f1_score_train_t, f1_score_test_t = getFScore(history_t)
f1_score_train_l, f1_score_test_l = getFScore(history_l)

epochs = range(30)
plt.figure(figsize = [15,10])
plt.plot(epochs,f1_score_test_t)
plt.plot(epochs,f1_score_train_t)
plt.plot(epochs,f1_score_test_l)
plt.plot(epochs,f1_score_train_l)

plt.grid("on")
plt.xlabel('epochs')
plt.ylabel('F-мера')
plt.legend(["F_test_Target","F_train_Target","F_test_label","F_train_label"])
```

Out[36]:

```
<matplotlib.legend.Legend at 0x7f378c19d910>
```



Вывод

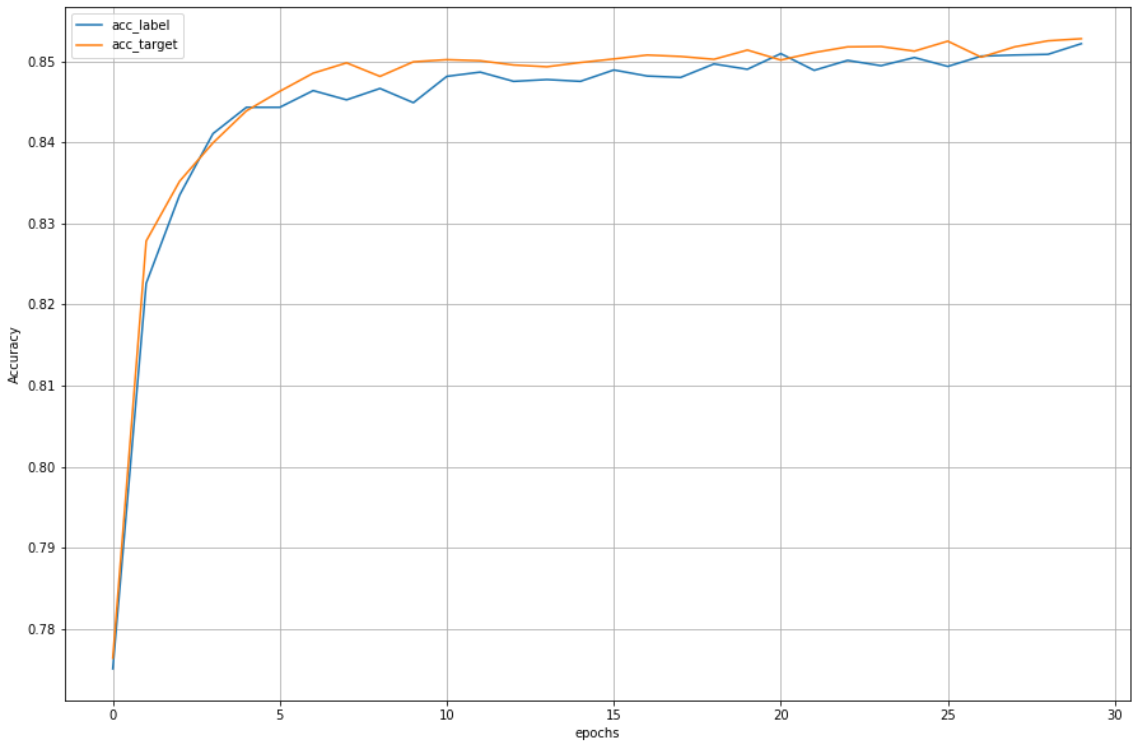
Из графика видно, что при на тестовой выборке различные виды кодирования категориальных признаков имеет практически одинаковое значение F-меры. Однако на тренировочной выборке значения отличаются в пользу TargetEncoding. Также заметно, что модель нейронной сети показывает лучшее значение, чем алгоритмы на основе деревьев.

In [38]:

```
epochs = range(30)
plt.figure(figsize = [15,10])
plt.plot(epochs,history_l.history["accuracy"])
plt.plot(epochs,history_t.history["accuracy"])
plt.grid("on")
plt.xlabel('epochs')
plt.ylabel('Accuracy')
plt.legend(["acc_label","acc_target"])
```

Out[38]:

```
<matplotlib.legend.Legend at 0x7f37e01e0dd0>
```



Вывод

Из графика видно, что различные виды кодирования категориальных признаков имеет практически одинаковое значение доли правильных ответов.

TargetEncoding

In [39]:

```
y_pred_t = model_t.predict(X_test_t)
confusion_matrix1 = confusion_matrix(np.argmax(y_test_t.values,axis=-1), np.argmax(y
_pred_t,axis = -1))
pd.DataFrame(data  =  confusion_matrix1,  columns  =  ['predicted >50',
'predicted <50'], index = ['actual >50', 'actual <50'])
```

Out[39]:

	predicted >50	predicted <50
actual >50	7052	353
actual <50	1078	1286

LabelEncoding

In [40]:

```
y_pred_l = model_l.predict(X_test_l)
confusion_matrix1 = confusion_matrix(np.argmax(y_test_l.values,axis=-1), np.argmax(y
_pred_l,axis = -1))
pd.DataFrame(data  =  confusion_matrix1,  columns  =  ['predicted >50',
'predicted <50'], index = ['actual >50', 'actual <50'])
```

Out[40]:

	predicted >50	predicted <50
actual >50	6936	427
actual <50	1138	1268

Новая модель сети

In [216]:

```
NB_CLASSES = y_train_t.shape[1]
INPUT_SHAPE = (X_train_t.shape[1],)
model = Sequential()
model.add(Dense(128, input_shape=INPUT_SHAPE,
                kernel_initializer='random_uniform',
#                kernel_regularizer=regularizers.l1_l2(l1=1e-4, l2=1e-3)
               ))
model.add(Activation('relu'))
model.add(Dropout(0.3))
model.add(Dense(64))
model.add(Activation('relu'))
# model.add(Dropout(0.3))
model.add(Dense(8))
model.add(Activation('relu'))
model.add(Dense(NB_CLASSES))
model.add(Dropout(0.3))
model.add(Activation('softmax'))
model.summary()
```

```
Model: "sequential_56"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
dense_223 (Dense)            (None, 128)               1920      
_________________________________________________________________
activation_222 (Activation)  (None, 128)               0         
_________________________________________________________________
dropout_117 (Dropout)        (None, 128)               0         
_________________________________________________________________
dense_224 (Dense)            (None, 64)                8256      
_________________________________________________________________
activation_223 (Activation)  (None, 64)                0         
_________________________________________________________________
dense_225 (Dense)            (None, 8)                 520       
_________________________________________________________________
activation_224 (Activation)  (None, 8)                 0         
_________________________________________________________________
dense_226 (Dense)            (None, 2)                 18        
_________________________________________________________________
dropout_118 (Dropout)        (None, 2)                 0         
_________________________________________________________________
activation_225 (Activation)  (None, 2)                 0         
=================================================================
Total params: 10,714
Trainable params: 10,714
Non-trainable params: 0
_________________________________________________________________
```

In [217]:

```
# opt = keras.optimizers.Adam(learning_rate=0.001)
model.compile(loss='binary_crossentropy',
              optimizer = 'adam',
              metrics=["accuracy",'Precision', 'Recall'])
```

In [218]:

```
history_t_new = modelLearning(X_train_t,X_test_t,y_train_t,y_test_t,model,1024,400)
```

```
Epoch 1/400
23/23 [==============================] - 0s 17ms/step - loss: 0.6265 -
accuracy: 0.7430 - precision: 0.7412 - recall: 0.6764 - val_loss: 0.548
4 - val_accuracy: 0.7565 - val_precision: 0.7565 - val_recall: 0.7565
Epoch 2/400
23/23 [==============================] - 0s 7ms/step - loss: 0.5133 - a
ccuracy: 0.7608 - precision: 0.7619 - recall: 0.6947 - val_loss: 0.4310
- val_accuracy: 0.7565 - val_precision: 0.7565 - val_recall: 0.7565
Epoch 3/400
23/23 [==============================] - 0s 7ms/step - loss: 0.4476 - a
ccuracy: 0.7877 - precision: 0.7891 - recall: 0.7189 - val_loss: 0.3998
- val_accuracy: 0.8301 - val_precision: 0.8301 - val_recall: 0.8301
Epoch 4/400
23/23 [==============================] - 0s 7ms/step - loss: 0.4250 - a
ccuracy: 0.8141 - precision: 0.8179 - recall: 0.7451 - val_loss: 0.3826
- val_accuracy: 0.8296 - val_precision: 0.8296 - val_recall: 0.8296
Epoch 5/400
23/23 [==============================] - 0s 7ms/step - loss: 0.4126 - a
ccuracy: 0.8189 - precision: 0.8258 - recall: 0.7517 - val_loss: 0.3685
- val_accuracy: 0.8317 - val_precision: 0.8317 - val_recall: 0.8317
Epoch 6/400
23/23 [==============================] - 0s 7ms/step - loss: 0.4041 - a
ccuracy: 0.8235 - precision: 0.8291 - recall: 0.7563 - val_loss: 0.3526
- val_accuracy: 0.8380 - val_precision: 0.8380 - val_recall: 0.8380
Epoch 7/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3972 - a
ccuracy: 0.8241 - precision: 0.8308 - recall: 0.7551 - val_loss: 0.3468
- val_accuracy: 0.8404 - val_precision: 0.8404 - val_recall: 0.8404
Epoch 8/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3925 - a
ccuracy: 0.8266 - precision: 0.8332 - recall: 0.7579 - val_loss: 0.3412
- val_accuracy: 0.8424 - val_precision: 0.8424 - val_recall: 0.8424
Epoch 9/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3879 - a
ccuracy: 0.8295 - precision: 0.8369 - recall: 0.7609 - val_loss: 0.3363
- val_accuracy: 0.8442 - val_precision: 0.8442 - val_recall: 0.8442
Epoch 10/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3866 - a
ccuracy: 0.8314 - precision: 0.8386 - recall: 0.7600 - val_loss: 0.3345
- val_accuracy: 0.8466 - val_precision: 0.8466 - val_recall: 0.8466
Epoch 11/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3795 - a
ccuracy: 0.8345 - precision: 0.8415 - recall: 0.7690 - val_loss: 0.3335
- val_accuracy: 0.8491 - val_precision: 0.8491 - val_recall: 0.8491
Epoch 12/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3772 - a
ccuracy: 0.8345 - precision: 0.8416 - recall: 0.7644 - val_loss: 0.3284
- val_accuracy: 0.8484 - val_precision: 0.8484 - val_recall: 0.8484
Epoch 13/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3750 - a
ccuracy: 0.8376 - precision: 0.8451 - recall: 0.7689 - val_loss: 0.3293
- val_accuracy: 0.8458 - val_precision: 0.8458 - val_recall: 0.8458
Epoch 14/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3769 - a
ccuracy: 0.8366 - precision: 0.8435 - recall: 0.7673 - val_loss: 0.3258
- val_accuracy: 0.8508 - val_precision: 0.8508 - val_recall: 0.8508
Epoch 15/400
```

```
23/23 [==============================] - 0s 7ms/step - loss: 0.3742 - a
ccuracy: 0.8370 - precision: 0.8432 - recall: 0.7665 - val_loss: 0.3256
- val_accuracy: 0.8527 - val_precision: 0.8527 - val_recall: 0.8527
Epoch 16/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3690 - a
ccuracy: 0.8395 - precision: 0.8469 - recall: 0.7741 - val_loss: 0.3227
- val_accuracy: 0.8527 - val_precision: 0.8527 - val_recall: 0.8527
Epoch 17/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3710 - a
ccuracy: 0.8384 - precision: 0.8458 - recall: 0.7706 - val_loss: 0.3207
- val_accuracy: 0.8534 - val_precision: 0.8534 - val_recall: 0.8534
Epoch 18/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3669 - a
ccuracy: 0.8425 - precision: 0.8505 - recall: 0.7736 - val_loss: 0.3196
- val_accuracy: 0.8525 - val_precision: 0.8525 - val_recall: 0.8525
Epoch 19/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3667 - a
ccuracy: 0.8408 - precision: 0.8483 - recall: 0.7731 - val_loss: 0.3227
- val_accuracy: 0.8511 - val_precision: 0.8511 - val_recall: 0.8511
Epoch 20/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3695 - a
ccuracy: 0.8383 - precision: 0.8460 - recall: 0.7705 - val_loss: 0.3182
- val_accuracy: 0.8528 - val_precision: 0.8528 - val_recall: 0.8528
Epoch 21/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3647 - a
ccuracy: 0.8403 - precision: 0.8483 - recall: 0.7697 - val_loss: 0.3169
- val_accuracy: 0.8539 - val_precision: 0.8539 - val_recall: 0.8539
Epoch 22/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3658 - a
ccuracy: 0.8421 - precision: 0.8497 - recall: 0.7718 - val_loss: 0.3174
- val_accuracy: 0.8552 - val_precision: 0.8552 - val_recall: 0.8552
Epoch 23/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3633 - a
ccuracy: 0.8413 - precision: 0.8493 - recall: 0.7725 - val_loss: 0.3189
- val_accuracy: 0.8519 - val_precision: 0.8519 - val_recall: 0.8519
Epoch 24/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3630 - a
ccuracy: 0.8396 - precision: 0.8486 - recall: 0.7701 - val_loss: 0.3164
- val_accuracy: 0.8519 - val_precision: 0.8519 - val_recall: 0.8519
Epoch 25/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3585 - a
ccuracy: 0.8442 - precision: 0.8520 - recall: 0.7763 - val_loss: 0.3153
- val_accuracy: 0.8538 - val_precision: 0.8538 - val_recall: 0.8538
Epoch 26/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3648 - a
ccuracy: 0.8417 - precision: 0.8490 - recall: 0.7738 - val_loss: 0.3189
- val_accuracy: 0.8505 - val_precision: 0.8505 - val_recall: 0.8505
Epoch 27/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3631 - a
ccuracy: 0.8409 - precision: 0.8491 - recall: 0.7744 - val_loss: 0.3145
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 28/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3631 - a
ccuracy: 0.8437 - precision: 0.8515 - recall: 0.7761 - val_loss: 0.3178
- val_accuracy: 0.8495 - val_precision: 0.8495 - val_recall: 0.8495
Epoch 29/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3633 - a
```

```
ccuracy: 0.8424 - precision: 0.8490 - recall: 0.7717 - val_loss: 0.3182
- val_accuracy: 0.8488 - val_precision: 0.8488 - val_recall: 0.8488
Epoch 30/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3597 - a
ccuracy: 0.8426 - precision: 0.8502 - recall: 0.7755 - val_loss: 0.3166
- val_accuracy: 0.8535 - val_precision: 0.8535 - val_recall: 0.8535
Epoch 31/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3590 - a
ccuracy: 0.8443 - precision: 0.8521 - recall: 0.7774 - val_loss: 0.3138
- val_accuracy: 0.8540 - val_precision: 0.8540 - val_recall: 0.8540
Epoch 32/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3634 - a
ccuracy: 0.8406 - precision: 0.8488 - recall: 0.7714 - val_loss: 0.3145
- val_accuracy: 0.8533 - val_precision: 0.8533 - val_recall: 0.8533
Epoch 33/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3611 - a
ccuracy: 0.8420 - precision: 0.8494 - recall: 0.7736 - val_loss: 0.3130
- val_accuracy: 0.8559 - val_precision: 0.8559 - val_recall: 0.8559
Epoch 34/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3622 - a
ccuracy: 0.8438 - precision: 0.8520 - recall: 0.7740 - val_loss: 0.3136
- val_accuracy: 0.8553 - val_precision: 0.8553 - val_recall: 0.8553
Epoch 35/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3625 - a
ccuracy: 0.8429 - precision: 0.8501 - recall: 0.7717 - val_loss: 0.3136
- val_accuracy: 0.8563 - val_precision: 0.8563 - val_recall: 0.8563
Epoch 36/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3618 - a
ccuracy: 0.8441 - precision: 0.8532 - recall: 0.7761 - val_loss: 0.3160
- val_accuracy: 0.8520 - val_precision: 0.8520 - val_recall: 0.8520
Epoch 37/400
23/23 [==============================] - 0s 19ms/step - loss: 0.3627 -
accuracy: 0.8395 - precision: 0.8480 - recall: 0.7718 - val_loss: 0.315
1 - val_accuracy: 0.8560 - val_precision: 0.8560 - val_recall: 0.8560
Epoch 38/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3609 - a
ccuracy: 0.8453 - precision: 0.8523 - recall: 0.7756 - val_loss: 0.3124
- val_accuracy: 0.8557 - val_precision: 0.8557 - val_recall: 0.8557
Epoch 39/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3610 - a
ccuracy: 0.8442 - precision: 0.8523 - recall: 0.7748 - val_loss: 0.3169
- val_accuracy: 0.8537 - val_precision: 0.8537 - val_recall: 0.8537
Epoch 40/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3597 - a
ccuracy: 0.8420 - precision: 0.8501 - recall: 0.7753 - val_loss: 0.3135
- val_accuracy: 0.8551 - val_precision: 0.8551 - val_recall: 0.8551
Epoch 41/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3601 - a
ccuracy: 0.8439 - precision: 0.8527 - recall: 0.7746 - val_loss: 0.3136
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 42/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3595 - a
ccuracy: 0.8446 - precision: 0.8518 - recall: 0.7729 - val_loss: 0.3147
- val_accuracy: 0.8552 - val_precision: 0.8552 - val_recall: 0.8552
Epoch 43/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3612 - a
ccuracy: 0.8446 - precision: 0.8525 - recall: 0.7759 - val_loss: 0.3131
```

```
- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 44/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3588 - a
ccuracy: 0.8430 - precision: 0.8512 - recall: 0.7740 - val_loss: 0.3143
- val_accuracy: 0.8534 - val_precision: 0.8534 - val_recall: 0.8534
Epoch 45/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3600 - a
ccuracy: 0.8444 - precision: 0.8521 - recall: 0.7739 - val_loss: 0.3123
- val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 46/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3587 - a
ccuracy: 0.8452 - precision: 0.8524 - recall: 0.7754 - val_loss: 0.3106
- val_accuracy: 0.8572 - val_precision: 0.8572 - val_recall: 0.8572
Epoch 47/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3550 - a
ccuracy: 0.8462 - precision: 0.8542 - recall: 0.7769 - val_loss: 0.3123
- val_accuracy: 0.8551 - val_precision: 0.8551 - val_recall: 0.8551
Epoch 48/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3565 - a
ccuracy: 0.8448 - precision: 0.8530 - recall: 0.7779 - val_loss: 0.3180
- val_accuracy: 0.8505 - val_precision: 0.8505 - val_recall: 0.8505
Epoch 49/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3609 - a
ccuracy: 0.8445 - precision: 0.8523 - recall: 0.7747 - val_loss: 0.3120
- val_accuracy: 0.8560 - val_precision: 0.8560 - val_recall: 0.8560
Epoch 50/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3562 - a
ccuracy: 0.8461 - precision: 0.8537 - recall: 0.7801 - val_loss: 0.3101
- val_accuracy: 0.8555 - val_precision: 0.8555 - val_recall: 0.8555
Epoch 51/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3556 - a
ccuracy: 0.8445 - precision: 0.8541 - recall: 0.7754 - val_loss: 0.3102
- val_accuracy: 0.8565 - val_precision: 0.8565 - val_recall: 0.8565
Epoch 52/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3575 - a
ccuracy: 0.8446 - precision: 0.8519 - recall: 0.7767 - val_loss: 0.3134
- val_accuracy: 0.8559 - val_precision: 0.8559 - val_recall: 0.8559
Epoch 53/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3603 - a
ccuracy: 0.8424 - precision: 0.8525 - recall: 0.7737 - val_loss: 0.3115
- val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 54/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3528 - a
ccuracy: 0.8451 - precision: 0.8557 - recall: 0.7777 - val_loss: 0.3131
- val_accuracy: 0.8561 - val_precision: 0.8561 - val_recall: 0.8561
Epoch 55/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3580 - a
ccuracy: 0.8437 - precision: 0.8512 - recall: 0.7754 - val_loss: 0.3112
- val_accuracy: 0.8553 - val_precision: 0.8553 - val_recall: 0.8553
Epoch 56/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3564 - a
ccuracy: 0.8448 - precision: 0.8526 - recall: 0.7778 - val_loss: 0.3131
- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 57/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3557 - a
ccuracy: 0.8434 - precision: 0.8534 - recall: 0.7765 - val_loss: 0.3135
- val_accuracy: 0.8516 - val_precision: 0.8516 - val_recall: 0.8516
```

```
Epoch 58/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3550 - a
ccuracy: 0.8453 - precision: 0.8532 - recall: 0.7788 - val_loss: 0.3129
- val_accuracy: 0.8521 - val_precision: 0.8521 - val_recall: 0.8521
Epoch 59/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3591 - a
ccuracy: 0.8432 - precision: 0.8511 - recall: 0.7749 - val_loss: 0.3109
- val_accuracy: 0.8556 - val_precision: 0.8556 - val_recall: 0.8556
Epoch 60/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3537 - a
ccuracy: 0.8450 - precision: 0.8520 - recall: 0.7774 - val_loss: 0.3125
- val_accuracy: 0.8561 - val_precision: 0.8561 - val_recall: 0.8561
Epoch 61/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3585 - a
ccuracy: 0.8461 - precision: 0.8537 - recall: 0.7764 - val_loss: 0.3107
- val_accuracy: 0.8560 - val_precision: 0.8560 - val_recall: 0.8560
Epoch 62/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3533 - a
ccuracy: 0.8450 - precision: 0.8531 - recall: 0.7787 - val_loss: 0.3108
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 63/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3540 - a
ccuracy: 0.8474 - precision: 0.8565 - recall: 0.7794 - val_loss: 0.3105
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 64/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3573 - a
ccuracy: 0.8435 - precision: 0.8500 - recall: 0.7756 - val_loss: 0.3097
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 65/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3568 - a
ccuracy: 0.8464 - precision: 0.8540 - recall: 0.7765 - val_loss: 0.3091
- val_accuracy: 0.8554 - val_precision: 0.8554 - val_recall: 0.8554
Epoch 66/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3538 - a
ccuracy: 0.8441 - precision: 0.8535 - recall: 0.7801 - val_loss: 0.3096
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 67/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3547 - a
ccuracy: 0.8446 - precision: 0.8525 - recall: 0.7738 - val_loss: 0.3091
- val_accuracy: 0.8571 - val_precision: 0.8571 - val_recall: 0.8571
Epoch 68/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3549 - a
ccuracy: 0.8460 - precision: 0.8549 - recall: 0.7800 - val_loss: 0.3113
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 69/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3528 - a
ccuracy: 0.8464 - precision: 0.8549 - recall: 0.7815 - val_loss: 0.3122
- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 70/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3569 - a
ccuracy: 0.8460 - precision: 0.8537 - recall: 0.7763 - val_loss: 0.3099
- val_accuracy: 0.8562 - val_precision: 0.8562 - val_recall: 0.8562
Epoch 71/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3574 - a
ccuracy: 0.8456 - precision: 0.8542 - recall: 0.7762 - val_loss: 0.3112
- val_accuracy: 0.8546 - val_precision: 0.8546 - val_recall: 0.8546
Epoch 72/400
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23/23 [==============================] - 0s 7ms/step - loss: 0.3554 - a
ccuracy: 0.8468 - precision: 0.8555 - recall: 0.7797 - val_loss: 0.3162
- val_accuracy: 0.8507 - val_precision: 0.8507 - val_recall: 0.8507
Epoch 73/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3585 - a
ccuracy: 0.8449 - precision: 0.8526 - recall: 0.7783 - val_loss: 0.3095
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 74/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3547 - a
ccuracy: 0.8434 - precision: 0.8525 - recall: 0.7761 - val_loss: 0.3093
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 75/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3529 - a
ccuracy: 0.8461 - precision: 0.8552 - recall: 0.7793 - val_loss: 0.3101
- val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 76/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3540 - a
ccuracy: 0.8462 - precision: 0.8551 - recall: 0.7793 - val_loss: 0.3085
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 77/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3567 - a
ccuracy: 0.8442 - precision: 0.8525 - recall: 0.7739 - val_loss: 0.3090
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 78/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3481 - a
ccuracy: 0.8475 - precision: 0.8574 - recall: 0.7832 - val_loss: 0.3095
- val_accuracy: 0.8573 - val_precision: 0.8573 - val_recall: 0.8573
Epoch 79/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3543 - a
ccuracy: 0.8448 - precision: 0.8540 - recall: 0.7782 - val_loss: 0.3107
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 80/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3516 - a
ccuracy: 0.8468 - precision: 0.8560 - recall: 0.7806 - val_loss: 0.3083
- val_accuracy: 0.8573 - val_precision: 0.8573 - val_recall: 0.8573
Epoch 81/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3530 - a
ccuracy: 0.8463 - precision: 0.8549 - recall: 0.7755 - val_loss: 0.3081
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 82/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3527 - a
ccuracy: 0.8456 - precision: 0.8564 - recall: 0.7758 - val_loss: 0.3093
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 83/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3542 - a
ccuracy: 0.8459 - precision: 0.8551 - recall: 0.7782 - val_loss: 0.3076
- val_accuracy: 0.8559 - val_precision: 0.8559 - val_recall: 0.8559
Epoch 84/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3554 - a
ccuracy: 0.8446 - precision: 0.8525 - recall: 0.7772 - val_loss: 0.3082
- val_accuracy: 0.8565 - val_precision: 0.8565 - val_recall: 0.8565
Epoch 85/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3490 - a
ccuracy: 0.8470 - precision: 0.8549 - recall: 0.7811 - val_loss: 0.3081
- val_accuracy: 0.8582 - val_precision: 0.8582 - val_recall: 0.8582
Epoch 86/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3524 - a
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ccuracy: 0.8454 - precision: 0.8550 - recall: 0.7808 - val_loss: 0.3094
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 87/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3515 - a
ccuracy: 0.8491 - precision: 0.8562 - recall: 0.7800 - val_loss: 0.3096
- val_accuracy: 0.8564 - val_precision: 0.8564 - val_recall: 0.8564
Epoch 88/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3530 -
accuracy: 0.8470 - precision: 0.8552 - recall: 0.7769 - val_loss: 0.307
7 - val_accuracy: 0.8590 - val_precision: 0.8590 - val_recall: 0.8590
Epoch 89/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3517 - a
ccuracy: 0.8474 - precision: 0.8551 - recall: 0.7780 - val_loss: 0.3067
- val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 90/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3523 -
accuracy: 0.8488 - precision: 0.8563 - recall: 0.7773 - val_loss: 0.310
5 - val_accuracy: 0.8548 - val_precision: 0.8548 - val_recall: 0.8548
Epoch 91/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3488 - a
ccuracy: 0.8467 - precision: 0.8563 - recall: 0.7798 - val_loss: 0.3077
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 92/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3518 - a
ccuracy: 0.8456 - precision: 0.8549 - recall: 0.7801 - val_loss: 0.3081
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 93/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3512 - a
ccuracy: 0.8463 - precision: 0.8536 - recall: 0.7803 - val_loss: 0.3077
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 94/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3507 - a
ccuracy: 0.8472 - precision: 0.8556 - recall: 0.7786 - val_loss: 0.3088
- val_accuracy: 0.8561 - val_precision: 0.8561 - val_recall: 0.8561
Epoch 95/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3539 - a
ccuracy: 0.8469 - precision: 0.8559 - recall: 0.7795 - val_loss: 0.3103
- val_accuracy: 0.8549 - val_precision: 0.8549 - val_recall: 0.8549
Epoch 96/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3545 - a
ccuracy: 0.8460 - precision: 0.8536 - recall: 0.7758 - val_loss: 0.3105
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 97/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3514 - a
ccuracy: 0.8486 - precision: 0.8564 - recall: 0.7812 - val_loss: 0.3106
- val_accuracy: 0.8562 - val_precision: 0.8562 - val_recall: 0.8562
Epoch 98/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3507 - a
ccuracy: 0.8443 - precision: 0.8516 - recall: 0.7772 - val_loss: 0.3117
- val_accuracy: 0.8524 - val_precision: 0.8524 - val_recall: 0.8524
Epoch 99/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3520 - a
ccuracy: 0.8452 - precision: 0.8541 - recall: 0.7747 - val_loss: 0.3093
- val_accuracy: 0.8564 - val_precision: 0.8564 - val_recall: 0.8564
Epoch 100/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3506 - a
ccuracy: 0.8480 - precision: 0.8576 - recall: 0.7803 - val_loss: 0.3075
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- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 101/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3510 - a
ccuracy: 0.8478 - precision: 0.8553 - recall: 0.7796 - val_loss: 0.3090
- val_accuracy: 0.8576 - val_precision: 0.8576 - val_recall: 0.8576
Epoch 102/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3512 - a
ccuracy: 0.8485 - precision: 0.8572 - recall: 0.7815 - val_loss: 0.3081
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 103/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3514 - a
ccuracy: 0.8456 - precision: 0.8536 - recall: 0.7778 - val_loss: 0.3072
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 104/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3489 - a
ccuracy: 0.8472 - precision: 0.8563 - recall: 0.7796 - val_loss: 0.3079
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 105/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3518 - a
ccuracy: 0.8474 - precision: 0.8561 - recall: 0.7777 - val_loss: 0.3071
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 106/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3481 - a
ccuracy: 0.8469 - precision: 0.8563 - recall: 0.7801 - val_loss: 0.3078
- val_accuracy: 0.8568 - val_precision: 0.8568 - val_recall: 0.8568
Epoch 107/400
23/23 [==============================] - 0s 12ms/step - loss: 0.3499 -
accuracy: 0.8459 - precision: 0.8545 - recall: 0.7776 - val_loss: 0.310
0 - val_accuracy: 0.8529 - val_precision: 0.8529 - val_recall: 0.8529
Epoch 108/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3508 - a
ccuracy: 0.8469 - precision: 0.8562 - recall: 0.7797 - val_loss: 0.3061
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 109/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3513 - a
ccuracy: 0.8470 - precision: 0.8561 - recall: 0.7764 - val_loss: 0.3086
- val_accuracy: 0.8561 - val_precision: 0.8561 - val_recall: 0.8561
Epoch 110/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3502 - a
ccuracy: 0.8482 - precision: 0.8574 - recall: 0.7773 - val_loss: 0.3073
- val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 111/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3509 - a
ccuracy: 0.8458 - precision: 0.8552 - recall: 0.7787 - val_loss: 0.3071
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 112/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3528 - a
ccuracy: 0.8468 - precision: 0.8563 - recall: 0.7761 - val_loss: 0.3071
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 113/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3490 - a
ccuracy: 0.8478 - precision: 0.8564 - recall: 0.7794 - val_loss: 0.3093
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 114/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3500 - a
ccuracy: 0.8451 - precision: 0.8540 - recall: 0.7775 - val_loss: 0.3071
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
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Epoch 115/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3495 - a
ccuracy: 0.8457 - precision: 0.8559 - recall: 0.7776 - val_loss: 0.3068
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 116/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3483 - a
ccuracy: 0.8472 - precision: 0.8561 - recall: 0.7787 - val_loss: 0.3063
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 117/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3517 - a
ccuracy: 0.8470 - precision: 0.8549 - recall: 0.7766 - val_loss: 0.3052
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 118/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3494 - a
ccuracy: 0.8471 - precision: 0.8564 - recall: 0.7782 - val_loss: 0.3052
- val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 119/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3474 - a
ccuracy: 0.8473 - precision: 0.8569 - recall: 0.7815 - val_loss: 0.3059
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 120/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3467 - a
ccuracy: 0.8464 - precision: 0.8551 - recall: 0.7797 - val_loss: 0.3083
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 121/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3518 - a
ccuracy: 0.8478 - precision: 0.8557 - recall: 0.7790 - val_loss: 0.3075
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 122/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3489 - a
ccuracy: 0.8477 - precision: 0.8562 - recall: 0.7816 - val_loss: 0.3092
- val_accuracy: 0.8537 - val_precision: 0.8537 - val_recall: 0.8537
Epoch 123/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3509 - a
ccuracy: 0.8463 - precision: 0.8544 - recall: 0.7756 - val_loss: 0.3070
- val_accuracy: 0.8568 - val_precision: 0.8568 - val_recall: 0.8568
Epoch 124/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3487 - a
ccuracy: 0.8479 - precision: 0.8570 - recall: 0.7820 - val_loss: 0.3083
- val_accuracy: 0.8560 - val_precision: 0.8560 - val_recall: 0.8560
Epoch 125/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3499 - a
ccuracy: 0.8464 - precision: 0.8555 - recall: 0.7780 - val_loss: 0.3066
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 126/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3516 - a
ccuracy: 0.8486 - precision: 0.8548 - recall: 0.7785 - val_loss: 0.3068
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 127/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3499 - a
ccuracy: 0.8497 - precision: 0.8572 - recall: 0.7811 - val_loss: 0.3054
- val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 128/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3501 - a
ccuracy: 0.8486 - precision: 0.8562 - recall: 0.7772 - val_loss: 0.3075
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 129/400
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23/23 [==============================] - 0s 6ms/step - loss: 0.3497 - a
ccuracy: 0.8478 - precision: 0.8568 - recall: 0.7797 - val_loss: 0.3066
- val_accuracy: 0.8573 - val_precision: 0.8573 - val_recall: 0.8573
Epoch 130/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3491 - a
ccuracy: 0.8460 - precision: 0.8556 - recall: 0.7771 - val_loss: 0.3071
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 131/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3476 - a
ccuracy: 0.8487 - precision: 0.8580 - recall: 0.7800 - val_loss: 0.3056
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 132/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3495 - a
ccuracy: 0.8490 - precision: 0.8559 - recall: 0.7792 - val_loss: 0.3076
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 133/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3502 - a
ccuracy: 0.8479 - precision: 0.8556 - recall: 0.7770 - val_loss: 0.3064
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 134/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3489 - a
ccuracy: 0.8459 - precision: 0.8556 - recall: 0.7783 - val_loss: 0.3075
- val_accuracy: 0.8563 - val_precision: 0.8563 - val_recall: 0.8563
Epoch 135/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3499 - a
ccuracy: 0.8473 - precision: 0.8564 - recall: 0.7776 - val_loss: 0.3063
- val_accuracy: 0.8594 - val_precision: 0.8594 - val_recall: 0.8594
Epoch 136/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3490 - a
ccuracy: 0.8475 - precision: 0.8562 - recall: 0.7787 - val_loss: 0.3075
- val_accuracy: 0.8590 - val_precision: 0.8590 - val_recall: 0.8590
Epoch 137/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3493 - a
ccuracy: 0.8460 - precision: 0.8548 - recall: 0.7784 - val_loss: 0.3097
- val_accuracy: 0.8571 - val_precision: 0.8571 - val_recall: 0.8571
Epoch 138/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3480 - a
ccuracy: 0.8487 - precision: 0.8561 - recall: 0.7802 - val_loss: 0.3067
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 139/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3491 - a
ccuracy: 0.8453 - precision: 0.8559 - recall: 0.7768 - val_loss: 0.3072
- val_accuracy: 0.8572 - val_precision: 0.8572 - val_recall: 0.8572
Epoch 140/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3453 - a
ccuracy: 0.8486 - precision: 0.8577 - recall: 0.7806 - val_loss: 0.3046
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 141/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3469 - a
ccuracy: 0.8476 - precision: 0.8555 - recall: 0.7800 - val_loss: 0.3061
- val_accuracy: 0.8612 - val_precision: 0.8612 - val_recall: 0.8612
Epoch 142/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3487 - a
ccuracy: 0.8474 - precision: 0.8559 - recall: 0.7797 - val_loss: 0.3101
- val_accuracy: 0.8532 - val_precision: 0.8532 - val_recall: 0.8532
Epoch 143/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3511 - a
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ccuracy: 0.8460 - precision: 0.8549 - recall: 0.7770 - val_loss: 0.3085
- val_accuracy: 0.8564 - val_precision: 0.8564 - val_recall: 0.8564
Epoch 144/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3506 - a
ccuracy: 0.8483 - precision: 0.8558 - recall: 0.7789 - val_loss: 0.3079
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 145/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3475 - a
ccuracy: 0.8463 - precision: 0.8559 - recall: 0.7769 - val_loss: 0.3067
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 146/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3470 - a
ccuracy: 0.8490 - precision: 0.8575 - recall: 0.7816 - val_loss: 0.3065
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 147/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3517 - a
ccuracy: 0.8474 - precision: 0.8562 - recall: 0.7770 - val_loss: 0.3067
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 148/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3489 - a
ccuracy: 0.8482 - precision: 0.8577 - recall: 0.7771 - val_loss: 0.3054
- val_accuracy: 0.8599 - val_precision: 0.8599 - val_recall: 0.8599
Epoch 149/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3465 - a
ccuracy: 0.8492 - precision: 0.8578 - recall: 0.7810 - val_loss: 0.3041
- val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 150/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3448 - a
ccuracy: 0.8464 - precision: 0.8562 - recall: 0.7779 - val_loss: 0.3075
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 151/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3462 - a
ccuracy: 0.8486 - precision: 0.8569 - recall: 0.7804 - val_loss: 0.3061
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 152/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3476 - a
ccuracy: 0.8498 - precision: 0.8571 - recall: 0.7818 - val_loss: 0.3061
- val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 153/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3502 - a
ccuracy: 0.8459 - precision: 0.8546 - recall: 0.7783 - val_loss: 0.3058
- val_accuracy: 0.8592 - val_precision: 0.8592 - val_recall: 0.8592
Epoch 154/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3470 - a
ccuracy: 0.8487 - precision: 0.8570 - recall: 0.7793 - val_loss: 0.3066
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 155/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3467 - a
ccuracy: 0.8493 - precision: 0.8572 - recall: 0.7804 - val_loss: 0.3056
- val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 156/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3498 - a
ccuracy: 0.8481 - precision: 0.8558 - recall: 0.7791 - val_loss: 0.3086
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 157/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3504 - a
ccuracy: 0.8481 - precision: 0.8567 - recall: 0.7798 - val_loss: 0.3110
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- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 158/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3501 - a
ccuracy: 0.8480 - precision: 0.8565 - recall: 0.7807 - val_loss: 0.3090
- val_accuracy: 0.8573 - val_precision: 0.8573 - val_recall: 0.8573
Epoch 159/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3480 - a
ccuracy: 0.8485 - precision: 0.8571 - recall: 0.7809 - val_loss: 0.3054
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 160/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3472 - a
ccuracy: 0.8489 - precision: 0.8569 - recall: 0.7817 - val_loss: 0.3059
- val_accuracy: 0.8582 - val_precision: 0.8582 - val_recall: 0.8582
Epoch 161/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3467 - a
ccuracy: 0.8487 - precision: 0.8563 - recall: 0.7808 - val_loss: 0.3067
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 162/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3472 - a
ccuracy: 0.8483 - precision: 0.8568 - recall: 0.7801 - val_loss: 0.3060
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 163/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3492 - a
ccuracy: 0.8482 - precision: 0.8557 - recall: 0.7792 - val_loss: 0.3106
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 164/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3496 - a
ccuracy: 0.8474 - precision: 0.8570 - recall: 0.7786 - val_loss: 0.3075
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 165/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3484 - a
ccuracy: 0.8489 - precision: 0.8576 - recall: 0.7784 - val_loss: 0.3080
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
Epoch 166/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3493 - a
ccuracy: 0.8473 - precision: 0.8545 - recall: 0.7801 - val_loss: 0.3069
- val_accuracy: 0.8594 - val_precision: 0.8594 - val_recall: 0.8594
Epoch 167/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3471 - a
ccuracy: 0.8478 - precision: 0.8585 - recall: 0.7807 - val_loss: 0.3066
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 168/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3478 - a
ccuracy: 0.8475 - precision: 0.8575 - recall: 0.7782 - val_loss: 0.3057
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 169/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3492 - a
ccuracy: 0.8491 - precision: 0.8571 - recall: 0.7755 - val_loss: 0.3069
- val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 170/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3478 - a
ccuracy: 0.8458 - precision: 0.8554 - recall: 0.7771 - val_loss: 0.3076
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 171/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3505 - a
ccuracy: 0.8505 - precision: 0.8589 - recall: 0.7794 - val_loss: 0.3064
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
```

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Epoch 172/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3516 - a
ccuracy: 0.8456 - precision: 0.8542 - recall: 0.7729 - val_loss: 0.3092
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 173/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3482 - a
ccuracy: 0.8481 - precision: 0.8572 - recall: 0.7795 - val_loss: 0.3076
- val_accuracy: 0.8571 - val_precision: 0.8571 - val_recall: 0.8571
Epoch 174/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3444 - a
ccuracy: 0.8488 - precision: 0.8578 - recall: 0.7821 - val_loss: 0.3089
- val_accuracy: 0.8559 - val_precision: 0.8559 - val_recall: 0.8559
Epoch 175/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3459 - a
ccuracy: 0.8480 - precision: 0.8552 - recall: 0.7811 - val_loss: 0.3053
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 176/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3461 - a
ccuracy: 0.8468 - precision: 0.8557 - recall: 0.7794 - val_loss: 0.3082
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 177/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3447 - a
ccuracy: 0.8493 - precision: 0.8583 - recall: 0.7830 - val_loss: 0.3063
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 178/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3472 - a
ccuracy: 0.8483 - precision: 0.8571 - recall: 0.7796 - val_loss: 0.3084
- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 179/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3451 - a
ccuracy: 0.8494 - precision: 0.8588 - recall: 0.7837 - val_loss: 0.3092
- val_accuracy: 0.8541 - val_precision: 0.8541 - val_recall: 0.8541
Epoch 180/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3462 - a
ccuracy: 0.8465 - precision: 0.8563 - recall: 0.7815 - val_loss: 0.3078
- val_accuracy: 0.8573 - val_precision: 0.8573 - val_recall: 0.8573
Epoch 181/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3491 - a
ccuracy: 0.8469 - precision: 0.8549 - recall: 0.7782 - val_loss: 0.3097
- val_accuracy: 0.8564 - val_precision: 0.8564 - val_recall: 0.8564
Epoch 182/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3491 - a
ccuracy: 0.8494 - precision: 0.8572 - recall: 0.7792 - val_loss: 0.3048
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 183/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3486 - a
ccuracy: 0.8486 - precision: 0.8573 - recall: 0.7780 - val_loss: 0.3068
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 184/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3471 - a
ccuracy: 0.8482 - precision: 0.8574 - recall: 0.7797 - val_loss: 0.3070
- val_accuracy: 0.8556 - val_precision: 0.8556 - val_recall: 0.8556
Epoch 185/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3477 - a
ccuracy: 0.8463 - precision: 0.8561 - recall: 0.7787 - val_loss: 0.3074
- val_accuracy: 0.8571 - val_precision: 0.8571 - val_recall: 0.8571
Epoch 186/400
```

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23/23 [==============================] - 0s 6ms/step - loss: 0.3464 - a
ccuracy: 0.8498 - precision: 0.8588 - recall: 0.7825 - val_loss: 0.3062
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 187/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3469 - a
ccuracy: 0.8498 - precision: 0.8589 - recall: 0.7794 - val_loss: 0.3049
- val_accuracy: 0.8597 - val_precision: 0.8597 - val_recall: 0.8597
Epoch 188/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3482 - a
ccuracy: 0.8476 - precision: 0.8569 - recall: 0.7801 - val_loss: 0.3062
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 189/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3479 - a
ccuracy: 0.8462 - precision: 0.8553 - recall: 0.7761 - val_loss: 0.3065
- val_accuracy: 0.8573 - val_precision: 0.8573 - val_recall: 0.8573
Epoch 190/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3447 - a
ccuracy: 0.8492 - precision: 0.8583 - recall: 0.7815 - val_loss: 0.3068
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 191/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3459 - a
ccuracy: 0.8477 - precision: 0.8564 - recall: 0.7763 - val_loss: 0.3071
- val_accuracy: 0.8568 - val_precision: 0.8568 - val_recall: 0.8568
Epoch 192/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3466 - a
ccuracy: 0.8491 - precision: 0.8575 - recall: 0.7818 - val_loss: 0.3070
- val_accuracy: 0.8595 - val_precision: 0.8595 - val_recall: 0.8595
Epoch 193/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3461 - a
ccuracy: 0.8492 - precision: 0.8581 - recall: 0.7798 - val_loss: 0.3096
- val_accuracy: 0.8557 - val_precision: 0.8557 - val_recall: 0.8557
Epoch 194/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3475 - a
ccuracy: 0.8478 - precision: 0.8559 - recall: 0.7785 - val_loss: 0.3097
- val_accuracy: 0.8536 - val_precision: 0.8536 - val_recall: 0.8536
Epoch 195/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3459 - a
ccuracy: 0.8478 - precision: 0.8572 - recall: 0.7805 - val_loss: 0.3066
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 196/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3448 - a
ccuracy: 0.8486 - precision: 0.8562 - recall: 0.7786 - val_loss: 0.3067
- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 197/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3454 - a
ccuracy: 0.8472 - precision: 0.8578 - recall: 0.7805 - val_loss: 0.3066
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 198/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3443 - a
ccuracy: 0.8507 - precision: 0.8593 - recall: 0.7832 - val_loss: 0.3064
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 199/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3465 - a
ccuracy: 0.8479 - precision: 0.8576 - recall: 0.7806 - val_loss: 0.3085
- val_accuracy: 0.8557 - val_precision: 0.8557 - val_recall: 0.8557
Epoch 200/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3465 - a
```

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ccuracy: 0.8485 - precision: 0.8575 - recall: 0.7814 - val_loss: 0.3126
- val_accuracy: 0.8535 - val_precision: 0.8535 - val_recall: 0.8535
Epoch 201/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3474 - a
ccuracy: 0.8473 - precision: 0.8569 - recall: 0.7813 - val_loss: 0.3090
- val_accuracy: 0.8542 - val_precision: 0.8542 - val_recall: 0.8542
Epoch 202/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3475 - a
ccuracy: 0.8483 - precision: 0.8563 - recall: 0.7794 - val_loss: 0.3083
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 203/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3485 - a
ccuracy: 0.8482 - precision: 0.8566 - recall: 0.7781 - val_loss: 0.3052
- val_accuracy: 0.8595 - val_precision: 0.8595 - val_recall: 0.8595
Epoch 204/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3450 - a
ccuracy: 0.8490 - precision: 0.8567 - recall: 0.7833 - val_loss: 0.3070
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 205/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3429 - a
ccuracy: 0.8495 - precision: 0.8587 - recall: 0.7831 - val_loss: 0.3088
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 206/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3476 - a
ccuracy: 0.8481 - precision: 0.8551 - recall: 0.7770 - val_loss: 0.3055
- val_accuracy: 0.8595 - val_precision: 0.8595 - val_recall: 0.8595
Epoch 207/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3441 - a
ccuracy: 0.8484 - precision: 0.8591 - recall: 0.7793 - val_loss: 0.3057
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 208/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3432 - a
ccuracy: 0.8505 - precision: 0.8597 - recall: 0.7819 - val_loss: 0.3070
- val_accuracy: 0.8596 - val_precision: 0.8596 - val_recall: 0.8596
Epoch 209/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3447 - a
ccuracy: 0.8499 - precision: 0.8594 - recall: 0.7821 - val_loss: 0.3063
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 210/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3442 - a
ccuracy: 0.8487 - precision: 0.8579 - recall: 0.7818 - val_loss: 0.3070
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 211/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3444 - a
ccuracy: 0.8484 - precision: 0.8563 - recall: 0.7794 - val_loss: 0.3061
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 212/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3424 - a
ccuracy: 0.8525 - precision: 0.8601 - recall: 0.7847 - val_loss: 0.3057
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 213/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3463 - a
ccuracy: 0.8481 - precision: 0.8568 - recall: 0.7787 - val_loss: 0.3074
- val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 214/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3476 - a
ccuracy: 0.8475 - precision: 0.8550 - recall: 0.7778 - val_loss: 0.3077
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- val_accuracy: 0.8585 - val_precision: 0.8585 - val_recall: 0.8585
Epoch 215/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3425 - a
ccuracy: 0.8511 - precision: 0.8588 - recall: 0.7848 - val_loss: 0.3082
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 216/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3464 - a
ccuracy: 0.8485 - precision: 0.8579 - recall: 0.7802 - val_loss: 0.3058
- val_accuracy: 0.8606 - val_precision: 0.8606 - val_recall: 0.8606
Epoch 217/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3448 - a
ccuracy: 0.8490 - precision: 0.8576 - recall: 0.7819 - val_loss: 0.3075
- val_accuracy: 0.8582 - val_precision: 0.8582 - val_recall: 0.8582
Epoch 218/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3444 - a
ccuracy: 0.8494 - precision: 0.8593 - recall: 0.7798 - val_loss: 0.3093
- val_accuracy: 0.8535 - val_precision: 0.8535 - val_recall: 0.8535
Epoch 219/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3475 - a
ccuracy: 0.8478 - precision: 0.8563 - recall: 0.7789 - val_loss: 0.3060
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 220/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3470 - a
ccuracy: 0.8488 - precision: 0.8573 - recall: 0.7787 - val_loss: 0.3062
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 221/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3454 - a
ccuracy: 0.8507 - precision: 0.8589 - recall: 0.7838 - val_loss: 0.3115
- val_accuracy: 0.8533 - val_precision: 0.8533 - val_recall: 0.8533
Epoch 222/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3430 - a
ccuracy: 0.8505 - precision: 0.8587 - recall: 0.7824 - val_loss: 0.3073
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 223/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3444 - a
ccuracy: 0.8496 - precision: 0.8581 - recall: 0.7818 - val_loss: 0.3050
- val_accuracy: 0.8595 - val_precision: 0.8595 - val_recall: 0.8595
Epoch 224/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3430 - a
ccuracy: 0.8489 - precision: 0.8575 - recall: 0.7812 - val_loss: 0.3088
- val_accuracy: 0.8551 - val_precision: 0.8551 - val_recall: 0.8551
Epoch 225/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3473 - a
ccuracy: 0.8481 - precision: 0.8560 - recall: 0.7778 - val_loss: 0.3051
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 226/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3440 - a
ccuracy: 0.8467 - precision: 0.8561 - recall: 0.7824 - val_loss: 0.3073
- val_accuracy: 0.8576 - val_precision: 0.8576 - val_recall: 0.8576
Epoch 227/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3426 - a
ccuracy: 0.8493 - precision: 0.8590 - recall: 0.7804 - val_loss: 0.3059
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 228/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3434 -
accuracy: 0.8478 - precision: 0.8579 - recall: 0.7792 - val_loss: 0.307
2 - val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
```

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Epoch 229/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3426 - a
ccuracy: 0.8498 - precision: 0.8590 - recall: 0.7820 - val_loss: 0.3079
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 230/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3463 -
accuracy: 0.8492 - precision: 0.8587 - recall: 0.7790 - val_loss: 0.310
1 - val_accuracy: 0.8555 - val_precision: 0.8555 - val_recall: 0.8555
Epoch 231/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3433 -
accuracy: 0.8494 - precision: 0.8584 - recall: 0.7840 - val_loss: 0.307
4 - val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 232/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3426 - a
ccuracy: 0.8506 - precision: 0.8605 - recall: 0.7815 - val_loss: 0.3075
- val_accuracy: 0.8551 - val_precision: 0.8551 - val_recall: 0.8551
Epoch 233/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3447 - a
ccuracy: 0.8486 - precision: 0.8568 - recall: 0.7797 - val_loss: 0.3066
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 234/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3432 - a
ccuracy: 0.8489 - precision: 0.8580 - recall: 0.7787 - val_loss: 0.3044
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
Epoch 235/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3426 - a
ccuracy: 0.8505 - precision: 0.8592 - recall: 0.7833 - val_loss: 0.3065
- val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 236/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3467 - a
ccuracy: 0.8506 - precision: 0.8602 - recall: 0.7784 - val_loss: 0.3058
- val_accuracy: 0.8568 - val_precision: 0.8568 - val_recall: 0.8568
Epoch 237/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3432 - a
ccuracy: 0.8500 - precision: 0.8583 - recall: 0.7815 - val_loss: 0.3067
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 238/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3396 - a
ccuracy: 0.8501 - precision: 0.8611 - recall: 0.7820 - val_loss: 0.3063
- val_accuracy: 0.8595 - val_precision: 0.8595 - val_recall: 0.8595
Epoch 239/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3436 - a
ccuracy: 0.8514 - precision: 0.8596 - recall: 0.7826 - val_loss: 0.3060
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
Epoch 240/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3429 - a
ccuracy: 0.8502 - precision: 0.8579 - recall: 0.7820 - val_loss: 0.3053
- val_accuracy: 0.8598 - val_precision: 0.8598 - val_recall: 0.8598
Epoch 241/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3417 - a
ccuracy: 0.8494 - precision: 0.8583 - recall: 0.7830 - val_loss: 0.3063
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 242/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3461 - a
ccuracy: 0.8476 - precision: 0.8570 - recall: 0.7765 - val_loss: 0.3090
- val_accuracy: 0.8556 - val_precision: 0.8556 - val_recall: 0.8556
Epoch 243/400
```

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23/23 [==============================] - 0s 6ms/step - loss: 0.3452 - a
ccuracy: 0.8476 - precision: 0.8568 - recall: 0.7778 - val_loss: 0.3051
- val_accuracy: 0.8573 - val_precision: 0.8573 - val_recall: 0.8573
Epoch 244/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3407 - a
ccuracy: 0.8488 - precision: 0.8571 - recall: 0.7804 - val_loss: 0.3049
- val_accuracy: 0.8585 - val_precision: 0.8585 - val_recall: 0.8585
Epoch 245/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3484 -
accuracy: 0.8490 - precision: 0.8581 - recall: 0.7807 - val_loss: 0.305
2 - val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 246/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3447 - a
ccuracy: 0.8511 - precision: 0.8604 - recall: 0.7829 - val_loss: 0.3064
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 247/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3432 - a
ccuracy: 0.8493 - precision: 0.8598 - recall: 0.7809 - val_loss: 0.3061
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 248/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3436 - a
ccuracy: 0.8504 - precision: 0.8590 - recall: 0.7827 - val_loss: 0.3063
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 249/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3441 - a
ccuracy: 0.8502 - precision: 0.8585 - recall: 0.7832 - val_loss: 0.3086
- val_accuracy: 0.8552 - val_precision: 0.8552 - val_recall: 0.8552
Epoch 250/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3461 - a
ccuracy: 0.8489 - precision: 0.8576 - recall: 0.7779 - val_loss: 0.3079
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 251/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3431 -
accuracy: 0.8521 - precision: 0.8587 - recall: 0.7821 - val_loss: 0.306
8 - val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 252/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3412 - a
ccuracy: 0.8480 - precision: 0.8589 - recall: 0.7817 - val_loss: 0.3116
- val_accuracy: 0.8563 - val_precision: 0.8563 - val_recall: 0.8563
Epoch 253/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3437 - a
ccuracy: 0.8511 - precision: 0.8600 - recall: 0.7830 - val_loss: 0.3066
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 254/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3435 - a
ccuracy: 0.8506 - precision: 0.8595 - recall: 0.7817 - val_loss: 0.3064
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
Epoch 255/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3420 - a
ccuracy: 0.8499 - precision: 0.8593 - recall: 0.7825 - val_loss: 0.3052
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 256/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3426 - a
ccuracy: 0.8503 - precision: 0.8576 - recall: 0.7816 - val_loss: 0.3059
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 257/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3410 - a
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ccuracy: 0.8500 - precision: 0.8591 - recall: 0.7800 - val_loss: 0.3109
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
Epoch 258/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3454 - a
ccuracy: 0.8499 - precision: 0.8572 - recall: 0.7797 - val_loss: 0.3084
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 259/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3428 - a
ccuracy: 0.8488 - precision: 0.8577 - recall: 0.7813 - val_loss: 0.3084
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 260/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3449 - a
ccuracy: 0.8492 - precision: 0.8579 - recall: 0.7814 - val_loss: 0.3056
- val_accuracy: 0.8585 - val_precision: 0.8585 - val_recall: 0.8585
Epoch 261/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3414 - a
ccuracy: 0.8515 - precision: 0.8601 - recall: 0.7837 - val_loss: 0.3072
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 262/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3424 - a
ccuracy: 0.8483 - precision: 0.8590 - recall: 0.7833 - val_loss: 0.3071
- val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 263/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3439 - a
ccuracy: 0.8492 - precision: 0.8587 - recall: 0.7818 - val_loss: 0.3051
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 264/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3434 - a
ccuracy: 0.8492 - precision: 0.8579 - recall: 0.7815 - val_loss: 0.3060
- val_accuracy: 0.8600 - val_precision: 0.8600 - val_recall: 0.8600
Epoch 265/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3425 - a
ccuracy: 0.8499 - precision: 0.8580 - recall: 0.7844 - val_loss: 0.3074
- val_accuracy: 0.8582 - val_precision: 0.8582 - val_recall: 0.8582
Epoch 266/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3443 - a
ccuracy: 0.8500 - precision: 0.8590 - recall: 0.7801 - val_loss: 0.3065
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 267/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3393 - a
ccuracy: 0.8490 - precision: 0.8585 - recall: 0.7820 - val_loss: 0.3065
- val_accuracy: 0.8564 - val_precision: 0.8564 - val_recall: 0.8564
Epoch 268/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3444 - a
ccuracy: 0.8505 - precision: 0.8603 - recall: 0.7812 - val_loss: 0.3107
- val_accuracy: 0.8536 - val_precision: 0.8536 - val_recall: 0.8536
Epoch 269/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3428 - a
ccuracy: 0.8502 - precision: 0.8585 - recall: 0.7796 - val_loss: 0.3078
- val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 270/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3407 - a
ccuracy: 0.8490 - precision: 0.8581 - recall: 0.7822 - val_loss: 0.3056
- val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 271/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3417 - a
ccuracy: 0.8509 - precision: 0.8600 - recall: 0.7824 - val_loss: 0.3055
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- val_accuracy: 0.8594 - val_precision: 0.8594 - val_recall: 0.8594
Epoch 272/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3432 - a
ccuracy: 0.8491 - precision: 0.8573 - recall: 0.7784 - val_loss: 0.3059
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 273/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3462 - a
ccuracy: 0.8496 - precision: 0.8590 - recall: 0.7755 - val_loss: 0.3048
- val_accuracy: 0.8595 - val_precision: 0.8595 - val_recall: 0.8595
Epoch 274/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3410 - a
ccuracy: 0.8499 - precision: 0.8580 - recall: 0.7805 - val_loss: 0.3075
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 275/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3432 - a
ccuracy: 0.8489 - precision: 0.8586 - recall: 0.7801 - val_loss: 0.3044
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 276/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3450 - a
ccuracy: 0.8496 - precision: 0.8575 - recall: 0.7789 - val_loss: 0.3068
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 277/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3388 - a
ccuracy: 0.8516 - precision: 0.8620 - recall: 0.7833 - val_loss: 0.3091
- val_accuracy: 0.8549 - val_precision: 0.8549 - val_recall: 0.8549
Epoch 278/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3413 - a
ccuracy: 0.8499 - precision: 0.8581 - recall: 0.7806 - val_loss: 0.3055
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 279/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3400 - a
ccuracy: 0.8511 - precision: 0.8599 - recall: 0.7850 - val_loss: 0.3057
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 280/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3415 - a
ccuracy: 0.8521 - precision: 0.8601 - recall: 0.7828 - val_loss: 0.3065
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 281/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3434 - a
ccuracy: 0.8503 - precision: 0.8587 - recall: 0.7826 - val_loss: 0.3084
- val_accuracy: 0.8555 - val_precision: 0.8555 - val_recall: 0.8555
Epoch 282/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3468 - a
ccuracy: 0.8475 - precision: 0.8561 - recall: 0.7773 - val_loss: 0.3100
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 283/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3419 - a
ccuracy: 0.8518 - precision: 0.8596 - recall: 0.7822 - val_loss: 0.3091
- val_accuracy: 0.8563 - val_precision: 0.8563 - val_recall: 0.8563
Epoch 284/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3423 - a
ccuracy: 0.8518 - precision: 0.8596 - recall: 0.7848 - val_loss: 0.3067
- val_accuracy: 0.8572 - val_precision: 0.8572 - val_recall: 0.8572
Epoch 285/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3468 - a
ccuracy: 0.8488 - precision: 0.8578 - recall: 0.7796 - val_loss: 0.3075
- val_accuracy: 0.8592 - val_precision: 0.8592 - val_recall: 0.8592
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Epoch 286/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3430 - a
ccuracy: 0.8510 - precision: 0.8592 - recall: 0.7799 - val_loss: 0.3058
- val_accuracy: 0.8574 - val_precision: 0.8574 - val_recall: 0.8574
Epoch 287/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3441 - a
ccuracy: 0.8508 - precision: 0.8598 - recall: 0.7802 - val_loss: 0.3065
- val_accuracy: 0.8585 - val_precision: 0.8585 - val_recall: 0.8585
Epoch 288/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3438 - a
ccuracy: 0.8512 - precision: 0.8588 - recall: 0.7827 - val_loss: 0.3065
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 289/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3420 - a
ccuracy: 0.8483 - precision: 0.8585 - recall: 0.7799 - val_loss: 0.3081
- val_accuracy: 0.8568 - val_precision: 0.8568 - val_recall: 0.8568
Epoch 290/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3417 - a
ccuracy: 0.8499 - precision: 0.8596 - recall: 0.7822 - val_loss: 0.3074
- val_accuracy: 0.8545 - val_precision: 0.8545 - val_recall: 0.8545
Epoch 291/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3415 - a
ccuracy: 0.8507 - precision: 0.8592 - recall: 0.7826 - val_loss: 0.3057
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 292/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3411 - a
ccuracy: 0.8510 - precision: 0.8592 - recall: 0.7846 - val_loss: 0.3077
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 293/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3454 - a
ccuracy: 0.8478 - precision: 0.8578 - recall: 0.7790 - val_loss: 0.3062
- val_accuracy: 0.8585 - val_precision: 0.8585 - val_recall: 0.8585
Epoch 294/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3413 - a
ccuracy: 0.8541 - precision: 0.8616 - recall: 0.7845 - val_loss: 0.3068
- val_accuracy: 0.8596 - val_precision: 0.8596 - val_recall: 0.8596
Epoch 295/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3413 - a
ccuracy: 0.8488 - precision: 0.8583 - recall: 0.7809 - val_loss: 0.3049
- val_accuracy: 0.8592 - val_precision: 0.8592 - val_recall: 0.8592
Epoch 296/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3406 - a
ccuracy: 0.8528 - precision: 0.8607 - recall: 0.7833 - val_loss: 0.3066
- val_accuracy: 0.8576 - val_precision: 0.8576 - val_recall: 0.8576
Epoch 297/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3400 - a
ccuracy: 0.8513 - precision: 0.8599 - recall: 0.7844 - val_loss: 0.3066
- val_accuracy: 0.8576 - val_precision: 0.8576 - val_recall: 0.8576
Epoch 298/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3411 - a
ccuracy: 0.8512 - precision: 0.8585 - recall: 0.7810 - val_loss: 0.3077
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 299/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3414 - a
ccuracy: 0.8512 - precision: 0.8610 - recall: 0.7811 - val_loss: 0.3078
- val_accuracy: 0.8564 - val_precision: 0.8564 - val_recall: 0.8564
Epoch 300/400
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23/23 [==============================] - 0s 6ms/step - loss: 0.3434 - a
ccuracy: 0.8497 - precision: 0.8575 - recall: 0.7785 - val_loss: 0.3071
- val_accuracy: 0.8594 - val_precision: 0.8594 - val_recall: 0.8594
Epoch 301/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3442 - a
ccuracy: 0.8512 - precision: 0.8604 - recall: 0.7823 - val_loss: 0.3087
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 302/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3395 - a
ccuracy: 0.8491 - precision: 0.8583 - recall: 0.7816 - val_loss: 0.3067
- val_accuracy: 0.8572 - val_precision: 0.8572 - val_recall: 0.8572
Epoch 303/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3408 - a
ccuracy: 0.8505 - precision: 0.8585 - recall: 0.7823 - val_loss: 0.3058
- val_accuracy: 0.8590 - val_precision: 0.8590 - val_recall: 0.8590
Epoch 304/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3415 - a
ccuracy: 0.8529 - precision: 0.8630 - recall: 0.7844 - val_loss: 0.3071
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 305/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3403 - a
ccuracy: 0.8513 - precision: 0.8603 - recall: 0.7840 - val_loss: 0.3083
- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 306/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3402 - a
ccuracy: 0.8512 - precision: 0.8602 - recall: 0.7825 - val_loss: 0.3062
- val_accuracy: 0.8572 - val_precision: 0.8572 - val_recall: 0.8572
Epoch 307/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3381 - a
ccuracy: 0.8506 - precision: 0.8594 - recall: 0.7838 - val_loss: 0.3072
- val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 308/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3431 - a
ccuracy: 0.8507 - precision: 0.8595 - recall: 0.7820 - val_loss: 0.3072
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 309/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3430 - a
ccuracy: 0.8511 - precision: 0.8599 - recall: 0.7840 - val_loss: 0.3060
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 310/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3429 - a
ccuracy: 0.8491 - precision: 0.8575 - recall: 0.7798 - val_loss: 0.3070
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 311/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3401 - a
ccuracy: 0.8513 - precision: 0.8610 - recall: 0.7860 - val_loss: 0.3047
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 312/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3435 - a
ccuracy: 0.8499 - precision: 0.8589 - recall: 0.7796 - val_loss: 0.3065
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
Epoch 313/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3401 - a
ccuracy: 0.8511 - precision: 0.8572 - recall: 0.7838 - val_loss: 0.3063
- val_accuracy: 0.8582 - val_precision: 0.8582 - val_recall: 0.8582
Epoch 314/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3422 - a
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ccuracy: 0.8496 - precision: 0.8574 - recall: 0.7795 - val_loss: 0.3057
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 315/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3409 - a
ccuracy: 0.8502 - precision: 0.8596 - recall: 0.7814 - val_loss: 0.3074
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 316/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3414 - a
ccuracy: 0.8527 - precision: 0.8605 - recall: 0.7833 - val_loss: 0.3087
- val_accuracy: 0.8562 - val_precision: 0.8562 - val_recall: 0.8562
Epoch 317/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3399 - a
ccuracy: 0.8521 - precision: 0.8606 - recall: 0.7832 - val_loss: 0.3080
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 318/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3415 - a
ccuracy: 0.8504 - precision: 0.8594 - recall: 0.7824 - val_loss: 0.3092
- val_accuracy: 0.8552 - val_precision: 0.8552 - val_recall: 0.8552
Epoch 319/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3394 - a
ccuracy: 0.8499 - precision: 0.8592 - recall: 0.7846 - val_loss: 0.3069
- val_accuracy: 0.8596 - val_precision: 0.8596 - val_recall: 0.8596
Epoch 320/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3401 - a
ccuracy: 0.8512 - precision: 0.8605 - recall: 0.7833 - val_loss: 0.3084
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 321/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3399 - a
ccuracy: 0.8507 - precision: 0.8606 - recall: 0.7836 - val_loss: 0.3095
- val_accuracy: 0.8554 - val_precision: 0.8554 - val_recall: 0.8554
Epoch 322/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3415 - a
ccuracy: 0.8503 - precision: 0.8586 - recall: 0.7798 - val_loss: 0.3063
- val_accuracy: 0.8597 - val_precision: 0.8597 - val_recall: 0.8597
Epoch 323/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3388 - a
ccuracy: 0.8522 - precision: 0.8613 - recall: 0.7842 - val_loss: 0.3071
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 324/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3377 -
 accuracy: 0.8509 - precision: 0.8615 - recall: 0.7833 - val_loss: 0.30
49 - val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 325/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3393 - a
ccuracy: 0.8507 - precision: 0.8597 - recall: 0.7827 - val_loss: 0.3084
- val_accuracy: 0.8570 - val_precision: 0.8570 - val_recall: 0.8570
Epoch 326/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3423 -
 accuracy: 0.8504 - precision: 0.8587 - recall: 0.7807 - val_loss: 0.30
87 - val_accuracy: 0.8537 - val_precision: 0.8537 - val_recall: 0.8537
Epoch 327/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3435 -
 accuracy: 0.8505 - precision: 0.8582 - recall: 0.7808 - val_loss: 0.30
71 - val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 328/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3419 -
 accuracy: 0.8510 - precision: 0.8589 - recall: 0.7834 - val_loss: 0.31
```

```
10 - val_accuracy: 0.8524 - val_precision: 0.8524 - val_recall: 0.8524
Epoch 329/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3413 -
 accuracy: 0.8506 - precision: 0.8594 - recall: 0.7810 - val_loss: 0.30
70 - val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 330/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3400 - a
ccuracy: 0.8514 - precision: 0.8612 - recall: 0.7827 - val_loss: 0.3067
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 331/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3399 - a
ccuracy: 0.8492 - precision: 0.8591 - recall: 0.7827 - val_loss: 0.3069
- val_accuracy: 0.8562 - val_precision: 0.8562 - val_recall: 0.8562
Epoch 332/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3421 -
 accuracy: 0.8486 - precision: 0.8577 - recall: 0.7786 - val_loss: 0.30
64 - val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 333/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3383 - a
ccuracy: 0.8505 - precision: 0.8600 - recall: 0.7835 - val_loss: 0.3061
- val_accuracy: 0.8599 - val_precision: 0.8599 - val_recall: 0.8599
Epoch 334/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3374 - a
ccuracy: 0.8514 - precision: 0.8611 - recall: 0.7868 - val_loss: 0.3087
- val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 335/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3363 - a
ccuracy: 0.8514 - precision: 0.8618 - recall: 0.7855 - val_loss: 0.3058
- val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 336/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3401 - a
ccuracy: 0.8521 - precision: 0.8610 - recall: 0.7828 - val_loss: 0.3062
- val_accuracy: 0.8583 - val_precision: 0.8583 - val_recall: 0.8583
Epoch 337/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3384 - a
ccuracy: 0.8526 - precision: 0.8618 - recall: 0.7843 - val_loss: 0.3093
- val_accuracy: 0.8553 - val_precision: 0.8553 - val_recall: 0.8553
Epoch 338/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3384 - a
ccuracy: 0.8508 - precision: 0.8598 - recall: 0.7847 - val_loss: 0.3071
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 339/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3367 - a
ccuracy: 0.8527 - precision: 0.8621 - recall: 0.7855 - val_loss: 0.3092
- val_accuracy: 0.8553 - val_precision: 0.8553 - val_recall: 0.8553
Epoch 340/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3400 - a
ccuracy: 0.8506 - precision: 0.8604 - recall: 0.7834 - val_loss: 0.3070
- val_accuracy: 0.8606 - val_precision: 0.8606 - val_recall: 0.8606
Epoch 341/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3393 - a
ccuracy: 0.8501 - precision: 0.8596 - recall: 0.7843 - val_loss: 0.3052
- val_accuracy: 0.8598 - val_precision: 0.8598 - val_recall: 0.8598
Epoch 342/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3376 - a
ccuracy: 0.8507 - precision: 0.8604 - recall: 0.7836 - val_loss: 0.3059
- val_accuracy: 0.8580 - val_precision: 0.8580 - val_recall: 0.8580
```

```
Epoch 343/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3391 - a
ccuracy: 0.8529 - precision: 0.8615 - recall: 0.7838 - val_loss: 0.3068
- val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 344/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3375 - a
ccuracy: 0.8532 - precision: 0.8628 - recall: 0.7829 - val_loss: 0.3059
- val_accuracy: 0.8561 - val_precision: 0.8561 - val_recall: 0.8561
Epoch 345/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3427 - a
ccuracy: 0.8508 - precision: 0.8590 - recall: 0.7808 - val_loss: 0.3073
- val_accuracy: 0.8566 - val_precision: 0.8566 - val_recall: 0.8566
Epoch 346/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3418 - a
ccuracy: 0.8510 - precision: 0.8594 - recall: 0.7832 - val_loss: 0.3066
- val_accuracy: 0.8601 - val_precision: 0.8601 - val_recall: 0.8601
Epoch 347/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3406 - a
ccuracy: 0.8517 - precision: 0.8608 - recall: 0.7811 - val_loss: 0.3070
- val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 348/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3405 - a
ccuracy: 0.8519 - precision: 0.8606 - recall: 0.7836 - val_loss: 0.3068
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 349/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3401 - a
ccuracy: 0.8506 - precision: 0.8603 - recall: 0.7821 - val_loss: 0.3071
- val_accuracy: 0.8592 - val_precision: 0.8592 - val_recall: 0.8592
Epoch 350/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3393 - a
ccuracy: 0.8504 - precision: 0.8592 - recall: 0.7816 - val_loss: 0.3073
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 351/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3404 - a
ccuracy: 0.8503 - precision: 0.8611 - recall: 0.7822 - val_loss: 0.3071
- val_accuracy: 0.8571 - val_precision: 0.8571 - val_recall: 0.8571
Epoch 352/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3404 - a
ccuracy: 0.8506 - precision: 0.8582 - recall: 0.7818 - val_loss: 0.3062
- val_accuracy: 0.8581 - val_precision: 0.8581 - val_recall: 0.8581
Epoch 353/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3378 - a
ccuracy: 0.8514 - precision: 0.8611 - recall: 0.7851 - val_loss: 0.3115
- val_accuracy: 0.8549 - val_precision: 0.8549 - val_recall: 0.8549
Epoch 354/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3421 -
 accuracy: 0.8482 - precision: 0.8582 - recall: 0.7805 - val_loss: 0.30
79 - val_accuracy: 0.8592 - val_precision: 0.8592 - val_recall: 0.8592
Epoch 355/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3393 - a
ccuracy: 0.8510 - precision: 0.8607 - recall: 0.7830 - val_loss: 0.3079
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 356/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3375 - a
ccuracy: 0.8503 - precision: 0.8595 - recall: 0.7827 - val_loss: 0.3073
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 357/400
```

```
23/23 [==============================] - 0s 8ms/step - loss: 0.3386 - a
ccuracy: 0.8504 - precision: 0.8592 - recall: 0.7819 - val_loss: 0.3097
- val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 358/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3414 - a
ccuracy: 0.8501 - precision: 0.8601 - recall: 0.7830 - val_loss: 0.3085
- val_accuracy: 0.8595 - val_precision: 0.8595 - val_recall: 0.8595
Epoch 359/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3366 - a
ccuracy: 0.8505 - precision: 0.8604 - recall: 0.7829 - val_loss: 0.3055
- val_accuracy: 0.8585 - val_precision: 0.8585 - val_recall: 0.8585
Epoch 360/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3445 - a
ccuracy: 0.8486 - precision: 0.8586 - recall: 0.7793 - val_loss: 0.3102
- val_accuracy: 0.8543 - val_precision: 0.8543 - val_recall: 0.8543
Epoch 361/400
23/23 [==============================] - 0s 6ms/step - loss: 0.3429 - a
ccuracy: 0.8507 - precision: 0.8596 - recall: 0.7795 - val_loss: 0.3086
- val_accuracy: 0.8578 - val_precision: 0.8578 - val_recall: 0.8578
Epoch 362/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3380 - a
ccuracy: 0.8497 - precision: 0.8596 - recall: 0.7835 - val_loss: 0.3070
- val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 363/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3399 - a
ccuracy: 0.8516 - precision: 0.8599 - recall: 0.7829 - val_loss: 0.3056
- val_accuracy: 0.8592 - val_precision: 0.8592 - val_recall: 0.8592
Epoch 364/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3369 - a
ccuracy: 0.8503 - precision: 0.8611 - recall: 0.7833 - val_loss: 0.3088
- val_accuracy: 0.8549 - val_precision: 0.8549 - val_recall: 0.8549
Epoch 365/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3389 - a
ccuracy: 0.8504 - precision: 0.8594 - recall: 0.7823 - val_loss: 0.3068
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 366/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3405 - a
ccuracy: 0.8505 - precision: 0.8597 - recall: 0.7819 - val_loss: 0.3075
- val_accuracy: 0.8609 - val_precision: 0.8609 - val_recall: 0.8609
Epoch 367/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3431 - a
ccuracy: 0.8490 - precision: 0.8582 - recall: 0.7786 - val_loss: 0.3104
- val_accuracy: 0.8551 - val_precision: 0.8551 - val_recall: 0.8551
Epoch 368/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3396 - a
ccuracy: 0.8499 - precision: 0.8588 - recall: 0.7816 - val_loss: 0.3079
- val_accuracy: 0.8589 - val_precision: 0.8589 - val_recall: 0.8589
Epoch 369/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3378 - a
ccuracy: 0.8523 - precision: 0.8622 - recall: 0.7854 - val_loss: 0.3081
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 370/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3400 - a
ccuracy: 0.8528 - precision: 0.8605 - recall: 0.7836 - val_loss: 0.3073
- val_accuracy: 0.8598 - val_precision: 0.8598 - val_recall: 0.8598
Epoch 371/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3371 - a
```

```
ccuracy: 0.8519 - precision: 0.8618 - recall: 0.7874 - val_loss: 0.3077
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 372/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3392 - a
ccuracy: 0.8514 - precision: 0.8606 - recall: 0.7834 - val_loss: 0.3063
- val_accuracy: 0.8601 - val_precision: 0.8601 - val_recall: 0.8601
Epoch 373/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3380 -
 accuracy: 0.8517 - precision: 0.8613 - recall: 0.7850 - val_loss: 0.30
66 - val_accuracy: 0.8591 - val_precision: 0.8591 - val_recall: 0.8591
Epoch 374/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3365 -
 accuracy: 0.8526 - precision: 0.8631 - recall: 0.7845 - val_loss: 0.30
61 - val_accuracy: 0.8601 - val_precision: 0.8601 - val_recall: 0.8601
Epoch 375/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3393 - a
ccuracy: 0.8515 - precision: 0.8602 - recall: 0.7808 - val_loss: 0.3079
- val_accuracy: 0.8594 - val_precision: 0.8594 - val_recall: 0.8594
Epoch 376/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3389 - a
ccuracy: 0.8510 - precision: 0.8599 - recall: 0.7826 - val_loss: 0.3079
- val_accuracy: 0.8551 - val_precision: 0.8551 - val_recall: 0.8551
Epoch 377/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3342 - a
ccuracy: 0.8503 - precision: 0.8606 - recall: 0.7840 - val_loss: 0.3084
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
Epoch 378/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3390 - a
ccuracy: 0.8494 - precision: 0.8592 - recall: 0.7844 - val_loss: 0.3118
- val_accuracy: 0.8552 - val_precision: 0.8552 - val_recall: 0.8552
Epoch 379/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3370 -
 accuracy: 0.8528 - precision: 0.8605 - recall: 0.7860 - val_loss: 0.30
72 - val_accuracy: 0.8588 - val_precision: 0.8588 - val_recall: 0.8588
Epoch 380/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3396 -
 accuracy: 0.8506 - precision: 0.8589 - recall: 0.7818 - val_loss: 0.30
85 - val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 381/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3387 - a
ccuracy: 0.8513 - precision: 0.8604 - recall: 0.7826 - val_loss: 0.3068
- val_accuracy: 0.8599 - val_precision: 0.8599 - val_recall: 0.8599
Epoch 382/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3374 - a
ccuracy: 0.8511 - precision: 0.8615 - recall: 0.7832 - val_loss: 0.3054
- val_accuracy: 0.8598 - val_precision: 0.8598 - val_recall: 0.8598
Epoch 383/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3361 - a
ccuracy: 0.8525 - precision: 0.8605 - recall: 0.7886 - val_loss: 0.3066
- val_accuracy: 0.8587 - val_precision: 0.8587 - val_recall: 0.8587
Epoch 384/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3394 - a
ccuracy: 0.8514 - precision: 0.8608 - recall: 0.7806 - val_loss: 0.3065
- val_accuracy: 0.8592 - val_precision: 0.8592 - val_recall: 0.8592
Epoch 385/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3380 - a
ccuracy: 0.8522 - precision: 0.8601 - recall: 0.7824 - val_loss: 0.3072
```

```
- val_accuracy: 0.8596 - val_precision: 0.8596 - val_recall: 0.8596
Epoch 386/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3367 - a
ccuracy: 0.8525 - precision: 0.8608 - recall: 0.7852 - val_loss: 0.3107
- val_accuracy: 0.8535 - val_precision: 0.8535 - val_recall: 0.8535
Epoch 387/400
23/23 [==============================] - 0s 13ms/step - loss: 0.3405 -
 accuracy: 0.8528 - precision: 0.8599 - recall: 0.7837 - val_loss: 0.30
67 - val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 388/400
23/23 [==============================] - 0s 12ms/step - loss: 0.3398 -
 accuracy: 0.8519 - precision: 0.8597 - recall: 0.7846 - val_loss: 0.30
90 - val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 389/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3391 - a
ccuracy: 0.8522 - precision: 0.8623 - recall: 0.7830 - val_loss: 0.3064
- val_accuracy: 0.8590 - val_precision: 0.8590 - val_recall: 0.8590
Epoch 390/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3361 -
 accuracy: 0.8530 - precision: 0.8617 - recall: 0.7850 - val_loss: 0.30
96 - val_accuracy: 0.8567 - val_precision: 0.8567 - val_recall: 0.8567
Epoch 391/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3389 - a
ccuracy: 0.8510 - precision: 0.8605 - recall: 0.7806 - val_loss: 0.3074
- val_accuracy: 0.8599 - val_precision: 0.8599 - val_recall: 0.8599
Epoch 392/400
23/23 [==============================] - 0s 10ms/step - loss: 0.3364 -
 accuracy: 0.8532 - precision: 0.8628 - recall: 0.7858 - val_loss: 0.30
84 - val_accuracy: 0.8575 - val_precision: 0.8575 - val_recall: 0.8575
Epoch 393/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3373 - a
ccuracy: 0.8539 - precision: 0.8629 - recall: 0.7883 - val_loss: 0.3099
- val_accuracy: 0.8569 - val_precision: 0.8569 - val_recall: 0.8569
Epoch 394/400
23/23 [==============================] - 0s 9ms/step - loss: 0.3399 - a
ccuracy: 0.8510 - precision: 0.8596 - recall: 0.7808 - val_loss: 0.3064
- val_accuracy: 0.8576 - val_precision: 0.8576 - val_recall: 0.8576
Epoch 395/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3398 - a
ccuracy: 0.8509 - precision: 0.8607 - recall: 0.7828 - val_loss: 0.3069
- val_accuracy: 0.8597 - val_precision: 0.8597 - val_recall: 0.8597
Epoch 396/400
23/23 [==============================] - 0s 11ms/step - loss: 0.3385 -
 accuracy: 0.8507 - precision: 0.8593 - recall: 0.7832 - val_loss: 0.30
60 - val_accuracy: 0.8579 - val_precision: 0.8579 - val_recall: 0.8579
Epoch 397/400
23/23 [==============================] - 0s 8ms/step - loss: 0.3391 - a
ccuracy: 0.8529 - precision: 0.8624 - recall: 0.7845 - val_loss: 0.3066
- val_accuracy: 0.8577 - val_precision: 0.8577 - val_recall: 0.8577
Epoch 398/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3377 - a
ccuracy: 0.8519 - precision: 0.8601 - recall: 0.7847 - val_loss: 0.3073
- val_accuracy: 0.8586 - val_precision: 0.8586 - val_recall: 0.8586
Epoch 399/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3380 - a
ccuracy: 0.8509 - precision: 0.8597 - recall: 0.7823 - val_loss: 0.3076
- val_accuracy: 0.8584 - val_precision: 0.8584 - val_recall: 0.8584
```

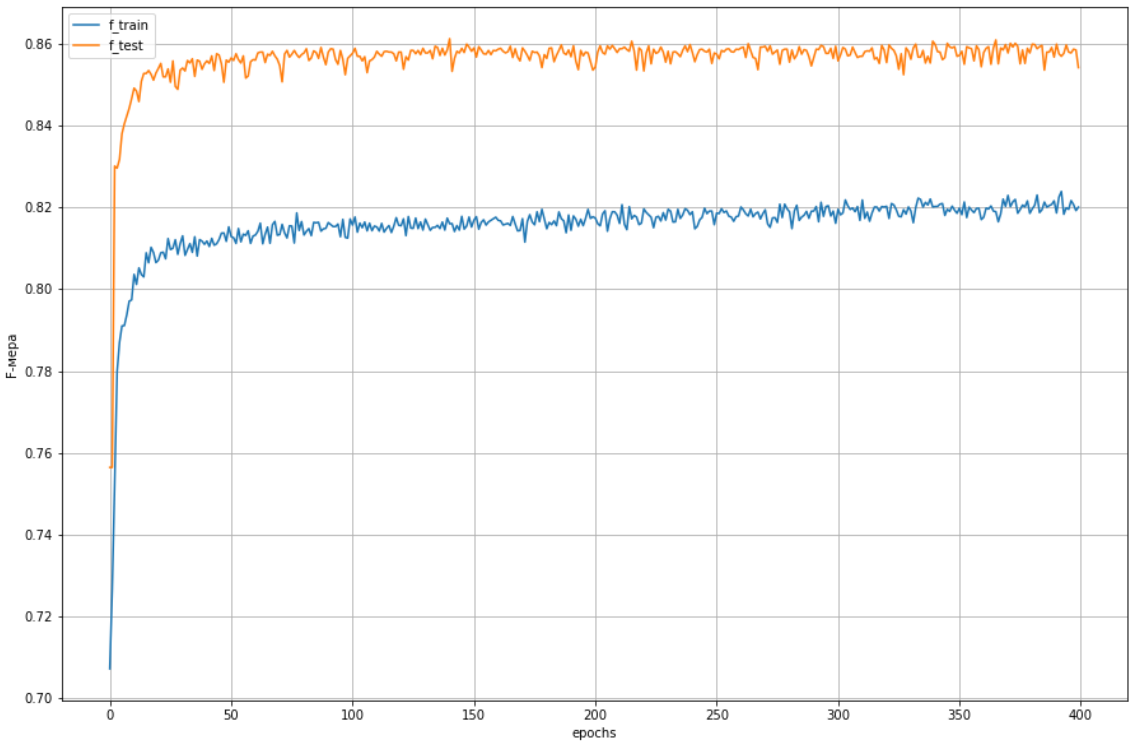
```
Epoch 400/400
23/23 [==============================] - 0s 7ms/step - loss: 0.3400 - a
ccuracy: 0.8526 - precision: 0.8601 - recall: 0.7835 - val_loss: 0.3097
- val_accuracy: 0.8541 - val_precision: 0.8541 - val_recall: 0.8541
```

In [219]:

```
f1_score_list_train = []
f1_score_list_test = []
for i in range(400):
    f1_score_list_train.append(2* history_t_new.history["precision"][i]*history_t_ne
w.history['recall'][i]/
                           (history_t_new.history["precision"][i]+history_t_new.hist
ory['recall'][i]))
    f1_score_list_test.append(2*history_t_new.history['val_precision'][i]*history_t_
new.history['val_recall'][i]/
                          (history_t_new.history['val_precision'][i]+history_t_new.h
istory['val_recall'][i]))
epochs = range(400)
plt.figure(figsize = [15,10])
plt.plot(epochs,f1_score_list_train)
plt.plot(epochs,f1_score_list_test)
plt.grid("on")
plt.xlabel('epochs')
plt.ylabel('F-мера')
plt.legend(["f_train","f_test"])
```

Out[219]:

```
<matplotlib.legend.Legend at 0x7f32284e14d0>
```



Вывод

Из графика видно, что оптимальным количеством эпох является ~ 150 Также заметно, что значение F-меры также улучшилось по сравнению с первоначальной моделью. В дамнной модели особенностью является увеличение числа скрытых нейронов, а также использование прореживания для регйляризации данных.

OneHotEncoding

In [121]:

```
X_train_O,X_test_O,y_train_O,y_test_O = prepareData(data_One)
```

In [152]:

```
NB_CLASSES = y_train_0.shape[1]
INPUT_SHAPE = (X_train_0.shape[1],)
model_0 = Sequential()
model_0.add(Dense(32, input_shape=INPUT_SHAPE,
                 kernel_initializer='random_uniform',
                kernel_regularizer=regularizers.l1_l2(l1=1e-4, l2=1e-3)
                ))
model_0.add(Activation('relu'))
model_0.add(Dropout(0.3))
model_0.add(Dense(16))
model_0.add(Activation('relu'))
model_0.add(Dropout(0.3))
model_0.add(Dense(8))
model_0.add(Activation('relu'))
model_0.add(Dropout(0.3))
model_0.add(Dense(NB_CLASSES))
# model_0.add(Dropout(0.3))
model_0.add(Activation('softmax'))
model_0.summary()
```

```
Model: "sequential_6"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_24 (Dense)             (None, 32)                3488
_________________________________________________________________
activation_24 (Activation)   (None, 32)                0
_________________________________________________________________
dropout_8 (Dropout)          (None, 32)                0
_________________________________________________________________
dense_25 (Dense)             (None, 16)                528
_________________________________________________________________
activation_25 (Activation)   (None, 16)                0
_________________________________________________________________
dropout_9 (Dropout)          (None, 16)                0
_________________________________________________________________
dense_26 (Dense)             (None, 8)                 136
_________________________________________________________________
activation_26 (Activation)   (None, 8)                 0
_________________________________________________________________
dropout_10 (Dropout)         (None, 8)                 0
_________________________________________________________________
dense_27 (Dense)             (None, 2)                 18
_________________________________________________________________
activation_27 (Activation)   (None, 2)                 0
=================================================================
Total params: 4,170
Trainable params: 4,170
Non-trainable params: 0
_________________________________________________________________
```

In [153]:

```
model_0.compile(loss='binary_crossentropy',
              optimizer = 'adam',
              metrics=["accuracy",'Precision', 'Recall'])
```

In [154]:

```
history_0 = modelLearning(X_train_0,X_test_0,y_train_0,y_test_0,model_0,128,100)
```

```
Epoch 1/100
179/179 [==============================] - 1s 6ms/step - loss: 0.5076 -
accuracy: 0.7525 - precision: 0.7526 - recall: 0.7525 - val_loss: 0.380
4 - val_accuracy: 0.8335 - val_precision: 0.8335 - val_recall: 0.8335
Epoch 2/100
179/179 [==============================] - 1s 4ms/step - loss: 0.4131 -
accuracy: 0.8044 - precision: 0.8044 - recall: 0.8044 - val_loss: 0.365
9 - val_accuracy: 0.8302 - val_precision: 0.8302 - val_recall: 0.8302
Epoch 3/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3969 -
accuracy: 0.8199 - precision: 0.8199 - recall: 0.8199 - val_loss: 0.356
5 - val_accuracy: 0.8387 - val_precision: 0.8387 - val_recall: 0.8387
Epoch 4/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3896 -
accuracy: 0.8270 - precision: 0.8270 - recall: 0.8270 - val_loss: 0.355
2 - val_accuracy: 0.8419 - val_precision: 0.8419 - val_recall: 0.8419
Epoch 5/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3782 -
accuracy: 0.8326 - precision: 0.8326 - recall: 0.8326 - val_loss: 0.347
1 - val_accuracy: 0.8407 - val_precision: 0.8407 - val_recall: 0.8407
Epoch 6/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3735 -
accuracy: 0.8349 - precision: 0.8349 - recall: 0.8349 - val_loss: 0.346
3 - val_accuracy: 0.8453 - val_precision: 0.8453 - val_recall: 0.8453
Epoch 7/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3678 -
accuracy: 0.8364 - precision: 0.8364 - recall: 0.8364 - val_loss: 0.345
0 - val_accuracy: 0.8469 - val_precision: 0.8469 - val_recall: 0.8469
Epoch 8/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3633 -
accuracy: 0.8398 - precision: 0.8398 - recall: 0.8398 - val_loss: 0.342
5 - val_accuracy: 0.8435 - val_precision: 0.8435 - val_recall: 0.8435
Epoch 9/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3665 -
accuracy: 0.8388 - precision: 0.8388 - recall: 0.8388 - val_loss: 0.340
6 - val_accuracy: 0.8466 - val_precision: 0.8466 - val_recall: 0.8466
Epoch 10/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3638 -
accuracy: 0.8378 - precision: 0.8378 - recall: 0.8378 - val_loss: 0.338
7 - val_accuracy: 0.8496 - val_precision: 0.8496 - val_recall: 0.8496
Epoch 11/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3603 -
accuracy: 0.8418 - precision: 0.8418 - recall: 0.8418 - val_loss: 0.341
8 - val_accuracy: 0.8507 - val_precision: 0.8507 - val_recall: 0.8507
Epoch 12/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3597 -
accuracy: 0.8395 - precision: 0.8395 - recall: 0.8395 - val_loss: 0.342
4 - val_accuracy: 0.8474 - val_precision: 0.8474 - val_recall: 0.8474
Epoch 13/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3599 -
accuracy: 0.8413 - precision: 0.8413 - recall: 0.8413 - val_loss: 0.338
8 - val_accuracy: 0.8501 - val_precision: 0.8501 - val_recall: 0.8501
Epoch 14/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3569 -
accuracy: 0.8408 - precision: 0.8408 - recall: 0.8408 - val_loss: 0.339
5 - val_accuracy: 0.8503 - val_precision: 0.8503 - val_recall: 0.8503
Epoch 15/100
```

```
179/179 [==============================] - 1s 5ms/step - loss: 0.3571 -
accuracy: 0.8421 - precision: 0.8421 - recall: 0.8421 - val_loss: 0.338
2 - val_accuracy: 0.8504 - val_precision: 0.8504 - val_recall: 0.8504
Epoch 16/100
179/179 [==============================] - 1s 7ms/step - loss: 0.3500 -
accuracy: 0.8435 - precision: 0.8435 - recall: 0.8435 - val_loss: 0.338
0 - val_accuracy: 0.8508 - val_precision: 0.8508 - val_recall: 0.8508
Epoch 17/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3529 -
accuracy: 0.8444 - precision: 0.8444 - recall: 0.8444 - val_loss: 0.340
1 - val_accuracy: 0.8441 - val_precision: 0.8441 - val_recall: 0.8441
Epoch 18/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3526 -
accuracy: 0.8422 - precision: 0.8422 - recall: 0.8422 - val_loss: 0.341
2 - val_accuracy: 0.8430 - val_precision: 0.8430 - val_recall: 0.8430
Epoch 19/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3500 -
accuracy: 0.8438 - precision: 0.8438 - recall: 0.8438 - val_loss: 0.337
1 - val_accuracy: 0.8505 - val_precision: 0.8505 - val_recall: 0.8505
Epoch 20/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3516 -
accuracy: 0.8447 - precision: 0.8447 - recall: 0.8447 - val_loss: 0.337
6 - val_accuracy: 0.8501 - val_precision: 0.8501 - val_recall: 0.8501
Epoch 21/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3488 -
accuracy: 0.8461 - precision: 0.8461 - recall: 0.8461 - val_loss: 0.334
8 - val_accuracy: 0.8523 - val_precision: 0.8523 - val_recall: 0.8523
Epoch 22/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3468 -
accuracy: 0.8475 - precision: 0.8475 - recall: 0.8475 - val_loss: 0.334
9 - val_accuracy: 0.8525 - val_precision: 0.8525 - val_recall: 0.8525
Epoch 23/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3494 -
accuracy: 0.8450 - precision: 0.8450 - recall: 0.8450 - val_loss: 0.339
0 - val_accuracy: 0.8511 - val_precision: 0.8511 - val_recall: 0.8511
Epoch 24/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3469 -
accuracy: 0.8472 - precision: 0.8472 - recall: 0.8472 - val_loss: 0.334
7 - val_accuracy: 0.8513 - val_precision: 0.8513 - val_recall: 0.8513
Epoch 25/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3448 -
accuracy: 0.8463 - precision: 0.8463 - recall: 0.8463 - val_loss: 0.333
7 - val_accuracy: 0.8508 - val_precision: 0.8508 - val_recall: 0.8508
Epoch 26/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3424 -
accuracy: 0.8508 - precision: 0.8508 - recall: 0.8508 - val_loss: 0.335
6 - val_accuracy: 0.8498 - val_precision: 0.8498 - val_recall: 0.8498
Epoch 27/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3436 -
accuracy: 0.8500 - precision: 0.8500 - recall: 0.8500 - val_loss: 0.334
4 - val_accuracy: 0.8503 - val_precision: 0.8503 - val_recall: 0.8503
Epoch 28/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3425 -
accuracy: 0.8494 - precision: 0.8494 - recall: 0.8494 - val_loss: 0.339
7 - val_accuracy: 0.8483 - val_precision: 0.8483 - val_recall: 0.8483
Epoch 29/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3425 -
```

```
accuracy: 0.8492 - precision: 0.8492 - recall: 0.8492 - val_loss: 0.336
8 - val_accuracy: 0.8478 - val_precision: 0.8478 - val_recall: 0.8478
Epoch 30/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3429 -
accuracy: 0.8464 - precision: 0.8464 - recall: 0.8464 - val_loss: 0.335
7 - val_accuracy: 0.8491 - val_precision: 0.8491 - val_recall: 0.8491
Epoch 31/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3431 -
accuracy: 0.8463 - precision: 0.8463 - recall: 0.8463 - val_loss: 0.334
5 - val_accuracy: 0.8518 - val_precision: 0.8518 - val_recall: 0.8518
Epoch 32/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3402 -
accuracy: 0.8477 - precision: 0.8477 - recall: 0.8477 - val_loss: 0.333
3 - val_accuracy: 0.8530 - val_precision: 0.8530 - val_recall: 0.8530
Epoch 33/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3398 -
accuracy: 0.8504 - precision: 0.8504 - recall: 0.8504 - val_loss: 0.334
3 - val_accuracy: 0.8491 - val_precision: 0.8491 - val_recall: 0.8491
Epoch 34/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3409 -
accuracy: 0.8478 - precision: 0.8478 - recall: 0.8478 - val_loss: 0.335
0 - val_accuracy: 0.8512 - val_precision: 0.8512 - val_recall: 0.8512
Epoch 35/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3396 -
accuracy: 0.8481 - precision: 0.8481 - recall: 0.8481 - val_loss: 0.333
7 - val_accuracy: 0.8486 - val_precision: 0.8486 - val_recall: 0.8486
Epoch 36/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3405 -
accuracy: 0.8491 - precision: 0.8491 - recall: 0.8491 - val_loss: 0.336
5 - val_accuracy: 0.8487 - val_precision: 0.8487 - val_recall: 0.8487
Epoch 37/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3439 -
accuracy: 0.8478 - precision: 0.8478 - recall: 0.8478 - val_loss: 0.331
6 - val_accuracy: 0.8523 - val_precision: 0.8523 - val_recall: 0.8523
Epoch 38/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3414 -
accuracy: 0.8479 - precision: 0.8479 - recall: 0.8479 - val_loss: 0.332
0 - val_accuracy: 0.8541 - val_precision: 0.8541 - val_recall: 0.8541
Epoch 39/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3357 -
accuracy: 0.8508 - precision: 0.8508 - recall: 0.8508 - val_loss: 0.334
7 - val_accuracy: 0.8512 - val_precision: 0.8512 - val_recall: 0.8512
Epoch 40/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3418 -
accuracy: 0.8483 - precision: 0.8483 - recall: 0.8483 - val_loss: 0.335
5 - val_accuracy: 0.8526 - val_precision: 0.8526 - val_recall: 0.8526
Epoch 41/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3417 -
accuracy: 0.8481 - precision: 0.8481 - recall: 0.8481 - val_loss: 0.333
0 - val_accuracy: 0.8527 - val_precision: 0.8527 - val_recall: 0.8527
Epoch 42/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3384 -
accuracy: 0.8512 - precision: 0.8512 - recall: 0.8512 - val_loss: 0.334
3 - val_accuracy: 0.8510 - val_precision: 0.8510 - val_recall: 0.8510
Epoch 43/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3417 -
accuracy: 0.8507 - precision: 0.8507 - recall: 0.8507 - val_loss: 0.330
```

```
1 - val_accuracy: 0.8510 - val_precision: 0.8510 - val_recall: 0.8510
Epoch 44/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3390 -
accuracy: 0.8471 - precision: 0.8471 - recall: 0.8471 - val_loss: 0.333
7 - val_accuracy: 0.8517 - val_precision: 0.8517 - val_recall: 0.8517
Epoch 45/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3427 -
accuracy: 0.8482 - precision: 0.8482 - recall: 0.8482 - val_loss: 0.337
9 - val_accuracy: 0.8502 - val_precision: 0.8502 - val_recall: 0.8502
Epoch 46/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3399 -
accuracy: 0.8493 - precision: 0.8493 - recall: 0.8493 - val_loss: 0.335
0 - val_accuracy: 0.8488 - val_precision: 0.8488 - val_recall: 0.8488
Epoch 47/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3395 -
accuracy: 0.8509 - precision: 0.8509 - recall: 0.8509 - val_loss: 0.335
2 - val_accuracy: 0.8492 - val_precision: 0.8492 - val_recall: 0.8492
Epoch 48/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3402 -
accuracy: 0.8504 - precision: 0.8504 - recall: 0.8504 - val_loss: 0.332
7 - val_accuracy: 0.8556 - val_precision: 0.8556 - val_recall: 0.8556
Epoch 49/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3378 -
accuracy: 0.8503 - precision: 0.8503 - recall: 0.8503 - val_loss: 0.333
5 - val_accuracy: 0.8522 - val_precision: 0.8522 - val_recall: 0.8522
Epoch 50/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3388 -
accuracy: 0.8497 - precision: 0.8497 - recall: 0.8497 - val_loss: 0.335
9 - val_accuracy: 0.8531 - val_precision: 0.8531 - val_recall: 0.8531
Epoch 51/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3391 -
accuracy: 0.8497 - precision: 0.8497 - recall: 0.8497 - val_loss: 0.333
4 - val_accuracy: 0.8524 - val_precision: 0.8524 - val_recall: 0.8524
Epoch 52/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3390 -
accuracy: 0.8491 - precision: 0.8491 - recall: 0.8491 - val_loss: 0.333
1 - val_accuracy: 0.8530 - val_precision: 0.8530 - val_recall: 0.8530
Epoch 53/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3414 -
accuracy: 0.8492 - precision: 0.8492 - recall: 0.8492 - val_loss: 0.331
4 - val_accuracy: 0.8540 - val_precision: 0.8540 - val_recall: 0.8540
Epoch 54/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3361 -
accuracy: 0.8505 - precision: 0.8505 - recall: 0.8505 - val_loss: 0.339
8 - val_accuracy: 0.8558 - val_precision: 0.8558 - val_recall: 0.8558
Epoch 55/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3349 -
accuracy: 0.8514 - precision: 0.8514 - recall: 0.8514 - val_loss: 0.333
9 - val_accuracy: 0.8483 - val_precision: 0.8483 - val_recall: 0.8483
Epoch 56/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3359 -
accuracy: 0.8510 - precision: 0.8510 - recall: 0.8510 - val_loss: 0.332
7 - val_accuracy: 0.8501 - val_precision: 0.8501 - val_recall: 0.8501
Epoch 57/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3360 -
accuracy: 0.8502 - precision: 0.8502 - recall: 0.8502 - val_loss: 0.334
7 - val_accuracy: 0.8492 - val_precision: 0.8492 - val_recall: 0.8492
```

```
Epoch 58/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3387 -
accuracy: 0.8489 - precision: 0.8489 - recall: 0.8489 - val_loss: 0.339
2 - val_accuracy: 0.8515 - val_precision: 0.8515 - val_recall: 0.8515
Epoch 59/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3378 -
accuracy: 0.8513 - precision: 0.8513 - recall: 0.8513 - val_loss: 0.337
5 - val_accuracy: 0.8549 - val_precision: 0.8549 - val_recall: 0.8549
Epoch 60/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3369 -
accuracy: 0.8480 - precision: 0.8480 - recall: 0.8480 - val_loss: 0.334
7 - val_accuracy: 0.8537 - val_precision: 0.8537 - val_recall: 0.8537
Epoch 61/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3390 -
accuracy: 0.8487 - precision: 0.8487 - recall: 0.8487 - val_loss: 0.331
4 - val_accuracy: 0.8536 - val_precision: 0.8536 - val_recall: 0.8536
Epoch 62/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3395 -
accuracy: 0.8508 - precision: 0.8508 - recall: 0.8508 - val_loss: 0.339
0 - val_accuracy: 0.8493 - val_precision: 0.8493 - val_recall: 0.8493
Epoch 63/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3360 -
accuracy: 0.8508 - precision: 0.8508 - recall: 0.8508 - val_loss: 0.337
8 - val_accuracy: 0.8533 - val_precision: 0.8533 - val_recall: 0.8533
Epoch 64/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3358 -
accuracy: 0.8497 - precision: 0.8497 - recall: 0.8497 - val_loss: 0.334
9 - val_accuracy: 0.8513 - val_precision: 0.8513 - val_recall: 0.8513
Epoch 65/100
179/179 [==============================] - 1s 7ms/step - loss: 0.3370 -
accuracy: 0.8528 - precision: 0.8528 - recall: 0.8528 - val_loss: 0.336
0 - val_accuracy: 0.8523 - val_precision: 0.8523 - val_recall: 0.8523
Epoch 66/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3372 -
accuracy: 0.8492 - precision: 0.8492 - recall: 0.8492 - val_loss: 0.338
0 - val_accuracy: 0.8552 - val_precision: 0.8552 - val_recall: 0.8552
Epoch 67/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3372 -
accuracy: 0.8511 - precision: 0.8511 - recall: 0.8511 - val_loss: 0.332
6 - val_accuracy: 0.8517 - val_precision: 0.8517 - val_recall: 0.8517
Epoch 68/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3367 -
accuracy: 0.8490 - precision: 0.8490 - recall: 0.8490 - val_loss: 0.334
9 - val_accuracy: 0.8526 - val_precision: 0.8526 - val_recall: 0.8526
Epoch 69/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3353 -
accuracy: 0.8506 - precision: 0.8506 - recall: 0.8506 - val_loss: 0.338
3 - val_accuracy: 0.8511 - val_precision: 0.8511 - val_recall: 0.8511
Epoch 70/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3364 -
accuracy: 0.8524 - precision: 0.8524 - recall: 0.8524 - val_loss: 0.332
5 - val_accuracy: 0.8527 - val_precision: 0.8527 - val_recall: 0.8527
Epoch 71/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3375 -
accuracy: 0.8506 - precision: 0.8506 - recall: 0.8506 - val_loss: 0.332
4 - val_accuracy: 0.8536 - val_precision: 0.8536 - val_recall: 0.8536
Epoch 72/100
```

```
179/179 [==============================] - 1s 5ms/step - loss: 0.3391 -
accuracy: 0.8504 - precision: 0.8504 - recall: 0.8504 - val_loss: 0.335
0 - val_accuracy: 0.8522 - val_precision: 0.8522 - val_recall: 0.8522
Epoch 73/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3385 -
accuracy: 0.8486 - precision: 0.8486 - recall: 0.8486 - val_loss: 0.335
1 - val_accuracy: 0.8536 - val_precision: 0.8536 - val_recall: 0.8536
Epoch 74/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3362 -
accuracy: 0.8526 - precision: 0.8526 - recall: 0.8526 - val_loss: 0.334
2 - val_accuracy: 0.8528 - val_precision: 0.8528 - val_recall: 0.8528
Epoch 75/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3357 -
accuracy: 0.8498 - precision: 0.8498 - recall: 0.8498 - val_loss: 0.334
6 - val_accuracy: 0.8497 - val_precision: 0.8497 - val_recall: 0.8497
Epoch 76/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3369 -
accuracy: 0.8506 - precision: 0.8506 - recall: 0.8506 - val_loss: 0.333
6 - val_accuracy: 0.8526 - val_precision: 0.8526 - val_recall: 0.8526
Epoch 77/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3377 -
accuracy: 0.8495 - precision: 0.8495 - recall: 0.8495 - val_loss: 0.340
5 - val_accuracy: 0.8552 - val_precision: 0.8552 - val_recall: 0.8552
Epoch 78/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3382 -
accuracy: 0.8515 - precision: 0.8515 - recall: 0.8515 - val_loss: 0.336
4 - val_accuracy: 0.8543 - val_precision: 0.8543 - val_recall: 0.8543
Epoch 79/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3385 -
accuracy: 0.8500 - precision: 0.8500 - recall: 0.8500 - val_loss: 0.339
9 - val_accuracy: 0.8520 - val_precision: 0.8520 - val_recall: 0.8520
Epoch 80/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3387 -
accuracy: 0.8492 - precision: 0.8492 - recall: 0.8492 - val_loss: 0.334
5 - val_accuracy: 0.8523 - val_precision: 0.8523 - val_recall: 0.8523
Epoch 81/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3377 -
accuracy: 0.8496 - precision: 0.8496 - recall: 0.8496 - val_loss: 0.334
3 - val_accuracy: 0.8542 - val_precision: 0.8542 - val_recall: 0.8542
Epoch 82/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3381 -
accuracy: 0.8514 - precision: 0.8514 - recall: 0.8514 - val_loss: 0.333
2 - val_accuracy: 0.8534 - val_precision: 0.8534 - val_recall: 0.8534
Epoch 83/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3374 -
accuracy: 0.8520 - precision: 0.8520 - recall: 0.8520 - val_loss: 0.332
7 - val_accuracy: 0.8568 - val_precision: 0.8568 - val_recall: 0.8568
Epoch 84/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3344 -
accuracy: 0.8525 - precision: 0.8525 - recall: 0.8525 - val_loss: 0.335
1 - val_accuracy: 0.8537 - val_precision: 0.8537 - val_recall: 0.8537
Epoch 85/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3351 -
accuracy: 0.8525 - precision: 0.8525 - recall: 0.8525 - val_loss: 0.335
0 - val_accuracy: 0.8527 - val_precision: 0.8527 - val_recall: 0.8527
Epoch 86/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3327 -
```

```
accuracy: 0.8533 - precision: 0.8533 - recall: 0.8533 - val_loss: 0.335
1 - val_accuracy: 0.8498 - val_precision: 0.8498 - val_recall: 0.8498
Epoch 87/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3380 -
accuracy: 0.8501 - precision: 0.8501 - recall: 0.8501 - val_loss: 0.335
0 - val_accuracy: 0.8483 - val_precision: 0.8483 - val_recall: 0.8483
Epoch 88/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3347 -
accuracy: 0.8511 - precision: 0.8511 - recall: 0.8511 - val_loss: 0.334
1 - val_accuracy: 0.8499 - val_precision: 0.8499 - val_recall: 0.8499
Epoch 89/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3366 -
accuracy: 0.8504 - precision: 0.8504 - recall: 0.8504 - val_loss: 0.333
7 - val_accuracy: 0.8563 - val_precision: 0.8563 - val_recall: 0.8563
Epoch 90/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3340 -
accuracy: 0.8520 - precision: 0.8520 - recall: 0.8520 - val_loss: 0.335
0 - val_accuracy: 0.8530 - val_precision: 0.8530 - val_recall: 0.8530
Epoch 91/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3367 -
accuracy: 0.8510 - precision: 0.8510 - recall: 0.8510 - val_loss: 0.337
3 - val_accuracy: 0.8498 - val_precision: 0.8498 - val_recall: 0.8498
Epoch 92/100
179/179 [==============================] - 1s 4ms/step - loss: 0.3379 -
accuracy: 0.8517 - precision: 0.8517 - recall: 0.8517 - val_loss: 0.337
7 - val_accuracy: 0.8528 - val_precision: 0.8528 - val_recall: 0.8528
Epoch 93/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3379 -
accuracy: 0.8480 - precision: 0.8480 - recall: 0.8480 - val_loss: 0.338
1 - val_accuracy: 0.8539 - val_precision: 0.8539 - val_recall: 0.8539
Epoch 94/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3363 -
accuracy: 0.8503 - precision: 0.8503 - recall: 0.8503 - val_loss: 0.334
8 - val_accuracy: 0.8525 - val_precision: 0.8525 - val_recall: 0.8525
Epoch 95/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3390 -
accuracy: 0.8507 - precision: 0.8507 - recall: 0.8507 - val_loss: 0.337
5 - val_accuracy: 0.8539 - val_precision: 0.8539 - val_recall: 0.8539
Epoch 96/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3393 -
accuracy: 0.8513 - precision: 0.8513 - recall: 0.8513 - val_loss: 0.333
4 - val_accuracy: 0.8538 - val_precision: 0.8538 - val_recall: 0.8538
Epoch 97/100
179/179 [==============================] - 1s 6ms/step - loss: 0.3375 -
accuracy: 0.8505 - precision: 0.8505 - recall: 0.8505 - val_loss: 0.333
6 - val_accuracy: 0.8533 - val_precision: 0.8533 - val_recall: 0.8533
Epoch 98/100
179/179 [==============================] - 1s 5ms/step - loss: 0.3380 -
accuracy: 0.8507 - precision: 0.8507 - recall: 0.8507 - val_loss: 0.335
9 - val_accuracy: 0.8510 - val_precision: 0.8510 - val_recall: 0.8510
Epoch 99/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3343 -
accuracy: 0.8527 - precision: 0.8527 - recall: 0.8527 - val_loss: 0.335
2 - val_accuracy: 0.8541 - val_precision: 0.8541 - val_recall: 0.8541
Epoch 100/100
179/179 [==============================] - 1s 3ms/step - loss: 0.3378 -
```

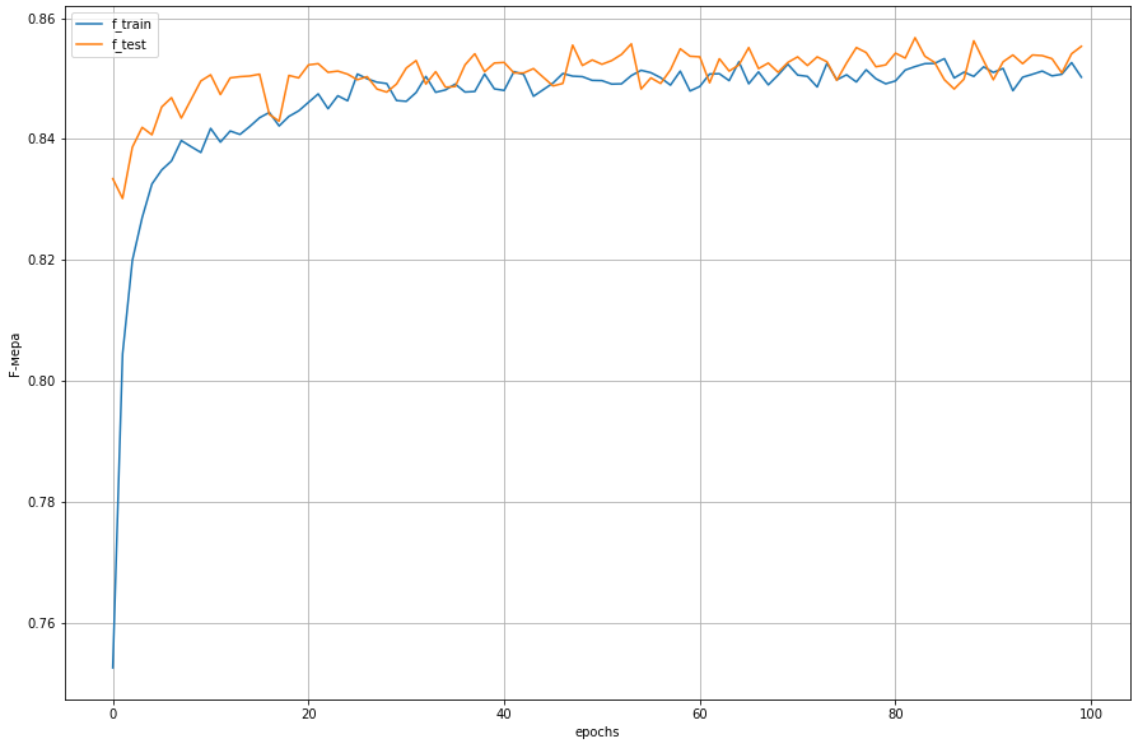
```
accuracy: 0.8503 - precision: 0.8503 - recall: 0.8503 - val_loss: 0.331
```

In [155]:

```
f1_score_list_train = []
f1_score_list_test = []
for i in range(100):
    f1_score_list_train.append(2* history_0.history["precision"][i]*history_0.histor
y['recall'][i]/
                               (history_0.history["precision"][i]+history_0.history['rec
all'][i]))
    f1_score_list_test.append(2*history_0.history['val_precision'][i]*history_0.hist
ory['val_recall'][i]/
                              (history_0.history['val_precision'][i]+history_0.history[
'val_recall'][i]))
epochs = range(100)
plt.figure(figsize = [15,10])
plt.plot(epochs,f1_score_list_train)
plt.plot(epochs,f1_score_list_test)
plt.grid("on")
plt.xlabel('epochs')
plt.ylabel('F-мера')
plt.legend(["f_train","f_test"])
```

Out[155]:

```
<matplotlib.legend.Legend at 0x7fa62e949a10>
```



Вывод

OneHotEncoding не дает особого преимущества относительно лругих вариантов кодирования. Кроме этого, в данной модели сети использовалась l1 и l2 регуляризация, что показывает, что алгоритм не переобучается на большом количестве эпох

In [ ]:

```
```